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THE GEOGRAPHICAL REVIEW

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OF NEW YORK

DECEMBER

1919

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THE
GEOGRAPHICAL REVIEW

VOL. VIII DECEMBER, 1919 NO. 6

CLIMATIC CYCLES AND EVOLUTION*

By GRIFFITH TAYLOR
Commonwealth of Australia Bureau of Meteorology

[With separate map, Pl. V, facing p. 312.]

Introduction

It has always been admitted that climate is one of the chief factors in determining evolution. That great changes have occurred in past climates has been accepted by geologists since the dawn of the glacial controversy, if not earlier. It is only of late, however, that the possibility of important changes in recent and historic times has been carefully investigated, by Huntington, Penck, J. W. Gregory, and others.

It is the purpose of this paper to show that there have been recurring cycles of such climatic change, cycles that have exercised perhaps paramount influence on the evolution of life.

Two cycles seem to be shown in the biological and geological record. The minor cycle recurs every 200,000 years or thereabouts and has determined the duration of the four Pleistocene ice ages and also the development and migrations of the four main races of man. The major cycle is about 100,000,000 years long, and we have a record of three such major cycles since the dawn of the Cambrian Age. The minor cycles are superimposed on the major cycles in such a fashion that in each major cycle, after long ages of fairly uniform climate throughout the world, there appears a zonal arrangement of climates. This culminates at the four great ice epochs, that is in late Proterozoic, Devonian, Permian, and late Tertiary times.

The gradual change of climate through late Tertiary times is first described as it has affected Australia. This constitutes Part I of the paper. Then the effect of climate on man's ethnological characters is briefly dis-

* All the footnote references, except 2, 5, 6, 7, 24, 26, 35, 37, 38, 40, 41, 47, have been supplied editorially. For these the author is therefore of course not responsible. Nor was it possible to send him proofs of the article for revision—EDIT. NOTE.

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cussed, and reasons are given for ignoring color as a major factor in race classification. The cephalic index and the hair, and to a lesser degree the culture of a race, are used as criteria.

A map of the world giving these characters for the primitive tribes (Pl. V) clearly indicates, as Matthew suggests,[1] that the biological center is in Asia and that all the races have migrated thence as a result of climatic thrusts. These latter were chiefly glacial at first and due to arid conditions later. Incidentally the "yellow" race is shown to have developed later than the "white."

Carrying the investigation back into earlier ages I find a similar sequence of climate for temperate regions. The four major ice ages are correlated with the striking breaks in the biological succession and with the periods of great mountain building. Evidence is given supporting the periodicity of these changes and indicating that a powerful weapon is thus placed in the hand of the geologist and biologist.

The time scale is then considered, especially in connection with radioactive experiments, and it is shown that to a certain extent it supports the cyclic hypothesis and enables us to fix absolute values for the major and minor periodic cycles.

Some suggestions as to the causes of these major and minor cycles are made. I especially wish to state, however, that, whether these suggestions be substantiated later or not, the earlier portions of the paper dealing with the periodicity of the phenomena will not be materially affected.

Part I

Late Paleoclimatology in Australia

For many years attention has been concentrated on the changes in temperature in past ages; but little has been written on the much more important feature—from the point of view of civilization—of rainfall.

The Rain Belt

In a model devised in 1912 (the solar-control model[2]) I was able to demonstrate how remarkably the continent of Australia lent itself to problems of climatology. The swing of the sun from tropic to tropic is followed by the swing of the isotherms. The latter reacts on the pressures, and the rains follow later, there being a lag of about five weeks.

From the present point of view it is important to note that the isohyets (rainfall) agree with the isotherms very remarkably. Moreover it is easy

[1] W. D. Matthew: Climate and Evolution, *Annals New York Acad. of Sci.*, Vol. 24, 1914, pp. 171-318; reference on p. 209.

[2] Griffith Taylor: The Australian Environment (Especially as Controlled by Rainfall), *Commonwealth of Australia Advisory Council of Science and Industry Memoir No. 1*, Melbourne, 1918; model inside front cover.

to plot the "center of aridity" month by month and relate it to the path of the sun and of the isotherms. This is shown in Figures 1 and 2. All the localities in Figure 1 are near longitude 135° E., and they show that the center of aridity moves north and south with the sun, but about four or five weeks later.

If we compare this belt of maximum aridity with the temperature, it is found to agree very closely with the isotherm of 75° F. In January this isotherm passes just north of the Great Australian Bight through Tarcoola (see Figs. 1 and 3). In April it passes between Oodnadatta and Daly Waters. In July it goes through Pine Creek. In fact it practically coincides with the driest place in each month, as the maps in Figure 2 demonstrate.

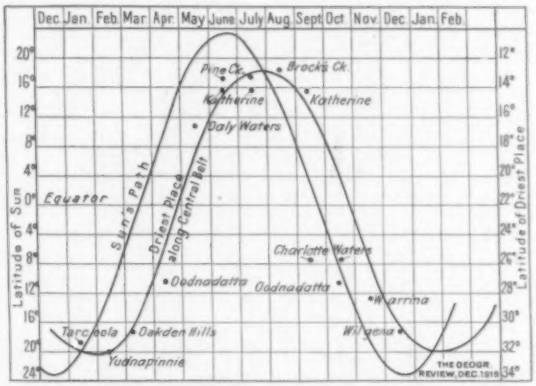

FIG. 1—Diagram showing the relation of the sun's march between the tropics to the march of the rain belt, illustrating the movement of the center of aridity across Australia. The driest spot in each month is used as index. (After Fig. 2 of the author's "The Australian Environment, Especially as Controlled by Rainfall," *Commonwealth of Australia Advisory Council of Science and Industry Memoir No. 1*, 1918.)

In a similar way the rain belts move *between* definite isotherms in Australia. There is no complication due to mountains or large gulfs; in fact Dame Nature has placed Australia like a blackboard on which fundamental climatic problems may be investigated.

The southern boundary of the tropical low-pressure rain belt (2-inch isohyet) agrees fairly well with the isotherm for 85° (see Fig. 2b). This isohyet defines the really heavy rains of the tropics, though of course there is some tropical rain south of the latitude concerned. The consequent hot moist climate only affects the continent for the three summer months in the tropics.

At this period (summer) central Australia has a hot arid climate, and the southern coast lands a cool arid climate. (In this discussion we are ignoring the east coast, where other factors affect the climate.) Only in Tasmania is the cool moist climate—which is that most favorable to civilized life—benefiting the land.

At the equinox (autumn, see Fig. 2c) the belts have moved north with the sun. The center of aridity (and the 75° isotherm) is now almost on the tropic. Tropical Australia is experiencing hot arid conditions, the central belt is cool and arid, the southern coast is cool and moist.

In winter the center of aridity runs through the northern coast lands

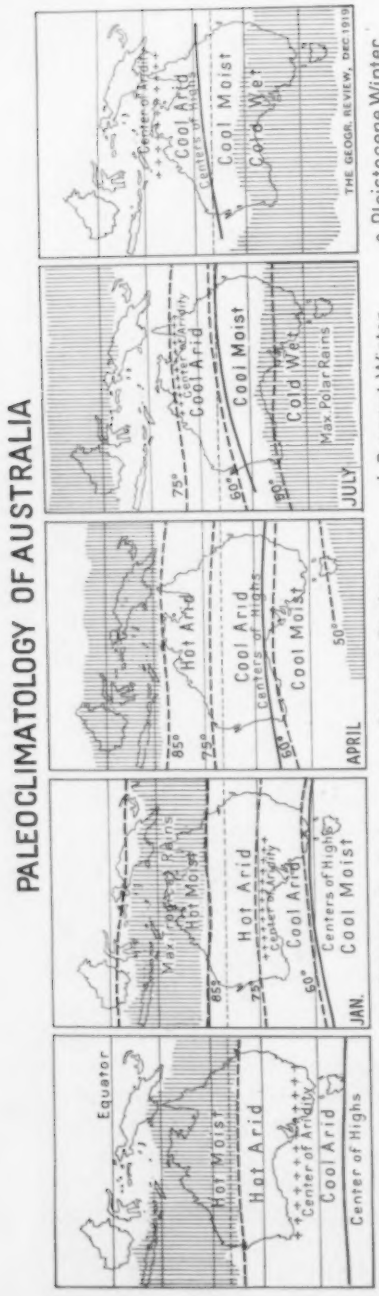

FIG. 2 (a to e)—Five maps showing the seasonal rain belts, Pliocene to present, in Australia. (Note—The Center of Aridity is lacking in Fig. 2c. It should lie just south of the 75° isotherm.)

(Fig. 2d), tropical Australia is largely cool and arid, the southern coast lands are cold and wet.

THE RAIN BELT IN PLEISTOCENE TIMES

Now suppose that the isotherms were all moved to the north, as would occur if the temperature of these latitudes fell, say, 5°; we should have the type of winter shown in Figure 2e. The center of aridity would coincide with Port Darwin (in winter). The whole of temperate Australia would be vastly improved in climate. Heavy rains would penetrate far north of their present limit. There would be a heavy snowfall on the Australian Alps, and glaciers would develop and reach down the valleys.

As we know, this is exactly what happened in Pleistocene times. Mt. Kosciusko shows many signs of glacial action, and a glacier three miles long and 1,000 feet thick extended down the valley of the Snowy River. At the present time only a few patches of snow exist through the summer on the sheltered eastern side of the range, though it reaches above 7,300 feet.

In Tasmania the glacial conditions were naturally more marked. I recently traced moraines which showed that in the National Park

(Mt. Field) a glacier about five miles long extended from the central range down the Broad River. Many fine cirques occur here, and also at Cradle Mountain and in the western mountains near Mt. Lyell.

As regards the lowlands in Australia there is overwhelming evidence of the happier conditions which obtained in Pleistocene times. Howchin

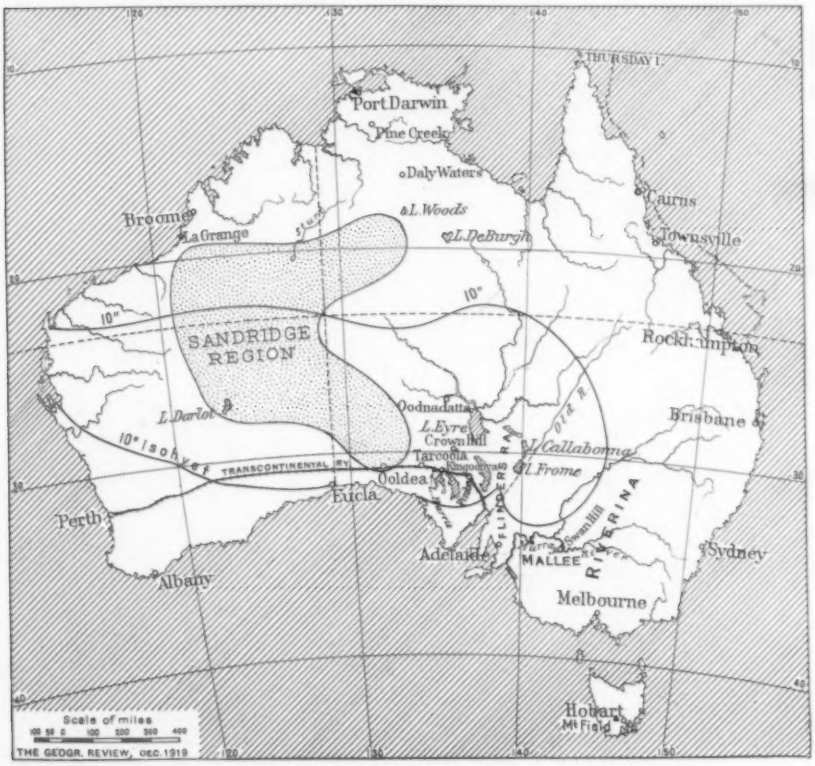

FIG. 3—Sketch map of Australia to illustrate Pleistocene conditions. Scale, 1:25,000,000.

has described[3] the course of large rivers which rivaled the present Murray and flowed south from Lake Eyre and Lake Frome.

The *Diprotodon*—a marsupial wombat as large as a rhinoceros—has been discovered in river and lake deposits throughout Australia. The most complete skeleton was obtained from the muds around Lake Callabonna (near Lake Frome; Fig. 3). But it is found near the arid Lake Darlot (Western Australia, latitude 28°) and all round Lake Eyre. It was a large herbivorous animal which certainly could not exist in a region which has only 7 inches of rain, as this region has at present. The present condition

[3] Walter Howchin: The Geography of South Australia, Including the Northern Territory, Historical Physical, Political, and Commercial, Melbourne, 1909, pp. 123-125.

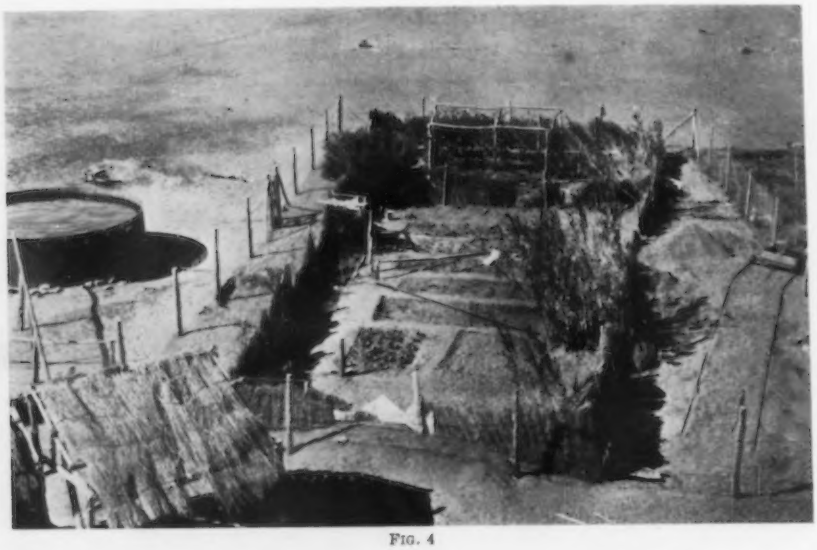

FIG. 4

FIG. 5

FIG. 4—View of Crown Hill "oasis," South Australia, 70 miles southwest of Lake Eyre—for location, see map, Fig. 3. (Photo by the author, May 15, 1919.)

The view is taken from the windmill platform. The water is a Tertiary supply about 70 feet down. The iron tank supplies the "oasis." This is surrounded by wire netting to keep out rabbits, emus, and kangaroos. Inside this is a brushwood fence to keep out the sand drift. The latter has, however, invaded the enclosure on the north (near) side. A small tramway (of iron pipes) and an improvised wagon have been used to cart the sand to the lee side. Some vines and a few fruit trees at the back and cabbages in front can be made out. There is no permanent settlement between this "station" and the Indian Ocean at La Grange—one thousand miles to the northwest.

FIG. 5—View of Ooldea Well, South Australia, on the Transcontinental Railway, long. 132° E. (Photo by the author, May 10, 1919.)

The southern end of the great sand-ridge region in Australia, which extends to the Indian Ocean. Here is the chief water supply on the Transcontinental Railway between Kingoonya (S. A.) and West Australia. The camels indicate the native well found by Giles in 1876. The dunes are about 150 feet high and run roughly northwest. The pipe lines (seen back of the tent) carry water pumped to the railway four miles south. The vegetation is "mulga."

FIG. 6

FIG. 7

FIG. 6—View of Lake Harris, a typical playa near Kingoonya, South Australia, on the Transcontinental Railway, long. 135° E. (Photo by the author, May 12, 1919.)

The man is holding slabs of salt which have crystallized on twigs. The crust is one inch thick. In the background is a fine mirage (on the right). The trees are acacias ("wattle"). This photograph was taken a stone's throw from the next.

FIG. 7—View of Tomato Rocks, Lake Harris, South Australia. (Photo by the author, May 12, 1919.)

A small gulley in a low rocky outcrop of very hard porphyry, about half a mile across. Here there is only a 7-inch rainfall per year. The numerous potholes indicate much greater rainfall in the past. These red rocks lie on the shore of Lake Harris—see Fig. 6—and rise to about 80 feet above the general level.

of this region is shown in the photograph of the Crown Hill "oasis" (Fig. 4), 70 miles southwest of Lake Eyre.

The vast alluvials of the Riverina region and western New South Wales indicate a period when numerous large rivers flowed into the Tertiary sea of the lower Murray basin. On the Victorian side of the lower Murray is the Mallee country, largely consisting of huge sand dunes which have blocked the Wimmera River and other tributaries of the Murray. The dunes are also found at Ooldea on the Transcontinental Railway and stretch almost uninterruptedly to the northwest—right to the Indian Ocean. These dunes are slowly moving south in some cases, though they are usually covered with mulga (*Acacia*), tea tree (*Leptospermum*), and dwarf eucalypts (see the photograph of Ooldea Well, Fig. 5).

It is to be noted that in 1914 the Murray, large river as it is, ceased to flow below Swan Hill. The last similar occurrence is said to have been in 1839.

The land forms tell a similar tale. All through the salt-lake district of South Australia there are preserved mature valleys which are certainly not those which would be produced by a 7-inch rainfall. Near Pimba these are especially noticeable. The salt lakes in many cases seem to be old river valleys blocked by silts rather than typical playas cut out by wind erosion. In some cases terraces are visible on the valley walls, but no detailed investigations have yet been made. Many of the small rock outcrops contain short gullies with all the characters of a pluvial cycle. The potholes at Tomato Rocks (cut in hard feldspar-porphyry), only a stone's throw from the salt expanse of the playa Lake Harris, offer an interesting illustration of climatic change (see Figs. 6 and 7).

Thus there is no doubt of the gradual desiccation of southern Australia in Pleistocene times. It is not due to the growth of the Flinders Range, however (as Howchin has suggested[4]), but to the migration of the polar rain belt to the south in accord with a general warming of the whole earth since the ice ages.

Penck has suggested[5] a similar course of events in other continents, especially in Africa and North America. It is obvious that there should be some corresponding improvement on the equatorial sides of the desert, for in Pleistocene times the northern portion of Australia was much more arid throughout the year than now. This is indicated by the sequence of Figures 2c, 2d, and 2e. Perhaps this is the reason that a xerophilous vegetation is throughout so characteristic of the Australian tropics (except the extreme east coast), for the Malaysian flora has not yet been able to creep back along the coastal fringe, even where conditions are suitable for its existence.

Very little physiographic work has been done in the north. Possibly the

[4] *Op. cit.*, p. 125.

[5] Albrecht Penck: The Shifting of the Climatic Belts. *Scottish Geogr. Mag.*, Vol. 30, 1914, pp. 281-293.

shallow depressions of Lake Woods and Lake De Burgh (lat. 18°-19°; cf. Fig. 3) are Pleistocene playas, which in the better rainfall of today are losing their desert characters. Sturt Creek runs into a "salt sea" (in latitude 20°) which is drinkable when it is full.[6] Here also the "sand ridges do not seem to be shifting perceptibly."[7]

In Pliocene Times

If we carry our survey farther back into the vistas of the past—as far as Pliocene times—we reach a period when all the evidence indicates a much warmer climate than obtains at present. Thus the Carolina flora flourished in France—which means that the temperature was about 5° warmer. Now 1° F. per degree of latitude is the normal horizontal temperature gradient. Hence the isotherms were displaced approximately about 5° of latitude (or 300 miles) toward the poles in Pliocene times.

I have indicated this in Figure 2a. We see that conditions in the south of Australia were probably much more arid than at present (Fig. 2c) in Pliocene summers. Possibly Australia south of the tropic received practically no rain all the year round, except along the eastern coast. We have not enough data to pursue this aspect further, but it is of interest to note that as far as we can tell all the present indications point to a temporary return to Pliocene conditions and to greater aridity in the south of Australia. Possibly the climatic belts will move south until the condition of Figure 2c (present) develops into that of Figure 2a (Pliocene).

Conclusions

In conclusion we see that an increase in the temperature of the middle latitudes—which chiefly interest the white man—causes a poleward movement of the equatorial low-pressure rain belt. This pushes the arid belt and the polar rain belts away from the equator, with tremendous results as regards the well-being of life in the belts affected.

This has been exemplified in Pliocene times, and we seem to be living in an era when the same trend obtains. This will benefit Canada and similar lands but will thwart development in Mediterranean lands and in southern Australia.

Conversely, if the general temperature decreases in our latitudes, the rain belts will move toward the equator. This occurred in Pleistocene times. Hence in the early historic age conditions were more favorable in regions like Babylon, Carthage, and Yucatan, where the climate is now too dry or too enervating. (Huntington has discussed this question[8] but does not seem to correlate their decadence with a "uni-directional" period of aridity so much as with a temporary arid "pulse.")

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[6] H. W. B. Talbot: Geological Observations in the Country Between Wiluna, Hall's Creek, and Tananu. *Western Australia Geol. Survey Bull. No. 39*, Perth, 1910, p. 57.

[7] *Ibid.*, p. 81.

[8] E. g. Ellsworth Huntington: Civilization and Climate, New Haven, 1915.

Part II

The Climatic Control of Color and of Other Characteristics of Man

Before investigating the evolution of the human races, it seems advisable to discuss the importance of color as a factor in ethnological classification.

Race Divisions by Color

The early division of the human race into white, yellow, and black does not appear to be logical in view of the general distribution of the various peoples. As I shall indicate, the following order of colors fits the data better: chocolate, red-brown, brown, olive, and yellow (Table I and Pl. V).

The white races are numerically unimportant, as are also the true black races. The South Europeans are certainly not white, nor are most of the negroes black. We may add that none of the red Indians are red, while the Australian blackfellow is chocolate!

It is most probable that primitive man was very hairy, and the Batwa of Central Africa still bear the fetal lanugo. Their chocolate color developed in accord with their original environment, which has possibly been hot and moist from Pliocene times (when, as is shown later, they probably lived near Persia) down to the present (when they live in the African forests).

The Negro

The negro developed in a somewhat cooler climate, where, however, it was still hot. He lost some of the pigment and became a red-brown. When he migrated, if he reached hotter lands, he tended to become more tanned (i. e. blacker). This was largely for physiological reasons, for this enabled the sweat glands to act more efficiently and so perhaps keep the body cool. In West Africa and in Papua—both lying near the equator—he tends to become sooty, but elsewhere few negroes are really black. The dark migrants who live in cold climates (e. g. the Tasmanians) have not become white, because in my opinion they have not been there long enough to lose their original color. Most of their evolution occurred in the hotter moister regions far to the north.

The Hamitic Peoples

The Hamitic peoples, as I shall show, probably developed in a cooler region again, after the Ice Age. This type was greatly benefited by a somewhat more strenuous climate in the original Asiatic home. His brain increased notably and became more compact in its cranium. His pigment decreased on the average, and he became a brown color. This color also kept much the same as he migrated with the oncoming Ice Age, for he kept to the same climatic belt if possible. If he wandered long years in cooler

regions, as did the American Hurons, the color tended to become lighter, towards olive. If he lived for long years in arid regions, he would tend to become yellow. This may explain the Hottentot coloring, though the Hottentot is, of course, a hybrid.

The Olive Peoples

In the same way the olive peoples on occupying Europe found a cool moist climate, not at all similar to their original home. Here they became "bleached," as Sergi pointed out.[9] The numerous and important olive races of America have kept to a large extent their original color because their climate is as a whole very like that of their original home.

Half-Castes

The question of half-castes of course somewhat complicates the problem. But the very fact that there is such a regular progression in every direction along the continents, outward from the Asiatic center, as my main thesis shows, is enough to prove that the climatic "thrust" was the chief factor in producing the migration zones. They are not due merely to the interbreeding of dissimilar autochthonous races.

The tendency among savage races has usually been to prevent breeding with dissimilar races, and many primitive peoples prohibit it by elaborate systems of rules and taboos. The casual newcomer was killed; while, if numerous enough, the invading hordes pushed the weaker races before them.

Stature

The stature of peoples would seem to be largely a question of favorable environment. It is certainly true that city-dwellers are shorter than farming peoples and that ill-nourished folk are usually small. This no doubt largely explains the short stature of the Eskimos, the Bushmen, etc. It is often pointed out that the Scotch and the Patagonians are the tallest races. Most people do not realize that large areas in western Patagonia have much the same environment as Scotland. It is not certain that small stature is necessarily a primitive character. The Negritos are small, but they have usually had a hand-to-mouth existence. The Neandertal type was tall and, as I suggest later, may have preceded the Negrito in the scale of human development.

Infantile Characters

There seems to be a fruitful field for research in the study of the fetal and infantile characters of the races. I have referred to the lanugo. It is said that the black negroes are red-brown at birth (while the reverse has

[9] Giuseppe Sergi: Europa: l'Origine dei popoli europei e loro relazione coi popoli d'Africa, d'Asia e d'Oceania, Turin, 1908, pp. 258, 259.

been stated for northern Australia); that the yellow peoples are paler at birth; that the Tibetan children have chestnut hair until they are six years old. These and many other points require investigation.

No doubt the psychology of the races will afford valuable evidence. The childlike behavior of the negro has often been referred to as a primitive characteristic. The white races are versatile, gay, and inventive—all attributes of youth. The yellow peoples are grave, meditative, and melancholic—which possibly indicates their more mature position in the evolution of races.

Conclusion

For the above reasons it certainly seems wise to lay little stress on color and stature as guides to the evolution of the races. Anatomical features and hair texture and section would appear to be the least variable characters, and I have used these throughout my study of the migrations. The data are derived largely from Deniker's works,[10] especially as regards the cephalic indices.

Part III

Climatic Control of the Migrations of Man

Although the details of Tertiary geography are not well known, it seems certain that by Pliocene times the continents had much the same outline as at present. The chief differences were the greater extent of Europe in the North Sea region and in the Mediterranean region. The Red Sea was absent, and a broad gulf occupied the Ural region connecting the Arctic Ocean with the Caspian. The land surface of the East Indies and of New Zealand was much greater (see Fig. 8).

There were many more land bridges (or corridors, as I propose to call them) between the continents in past history, and this greatly modified the main lines of man's migrations.

Corridors and Migrations

The characteristics of a migration have always been much the same throughout the ages. A modern "migration," such as that of a city crowd to a football match, presents some useful analogies. First come the lowest classes and pariahs, who wander freely over the ground long before the general public arrives. They have arrived there by the usual roads and tracks but ultimately are found perched in tree tops and in the least attractive positions of the ground. Then the proletariat advances along the same

[10] E. g. Joseph Deniker: Les races et les peuples de la terre: Éléments d'anthropologie et d'ethnographie, Paris, 1900.

Idem: Les six races composant la population actuelle de l'Europe (Huxley Lecture for 1904), *Journ. Anthropol. Inst. of Great Britain and Ireland*, Vol. 34, 1904, pp. 181-206.

roads and corridors. They are driven out of the best seats, which are reserved for the last comers.

In the past history of man he has moved along the same corridors, which, as noted above, were often much broader than at present. Thus the Red Sea corridor was open for many of the migrations from Central Asia toward the southwest. Gibraltar was a very favorite corridor during the earlier migrations but broke down later on. Bering Sea is still very shallow and crossed by drowned ranges (e. g. Aleutian Isles). Probably this also was dry land.

We have evidence of the enormous extent of New Zealand in Tertiary times, for it stretched nearly up to New Guinea. The same story is true of Malaysia, where the Bali-Lombok strait seems to have separated two large lands in Tertiary times. The more southern was almost certainly joined to Australia at first. No doubt North and South America were united by a broad Antillean region.

Tertiary Conditions

All the data gathered in recent years go to show that Tertiary times were much longer than has been generally supposed. Twenty-five or thirty million years is a fairly reasonable estimate. So, also, the birth of man can justifiably be pushed back one or two million years; and this allows time for much greater changes in the continents during the human era than the early geologists had been willing to grant.

The chief differences, however, between modern times and middle Tertiary times were in the elevation and especially in the climate. The latter was much warmer, as noted earlier; for trees such as sassafras, which are characteristic of an isotherm of 65° or 80°, grew readily in France (which is now 55°). We may assume that the world isotherms as a whole were moved poleward in accord with this evidence.

The great mountains of the world to a large extent came into being toward the end of Tertiary time. Thus Central Asia, in place of being an arid plateau at an elevation of 10,000 feet, as now, was previously probably something like the Central States of the United States, with a corresponding improvement in rainfall and temperature. The Central Asiatic deserts are largely rain-shadow deserts due to the mountains and are not true trade-wind deserts, like most of the other large arid regions in warm climates.

The Anthropoids

Data are very scanty as regards the evolution of man's forerunners, the anthropoids. If we plot the occurrences of Tertiary fossils (following Matthew[11]) we shall surely obtain a clue as to the limits of the hot moist forests. The Eocene monkeys occur in the central United States and in France, which indicates that at that time these were tropical forests such as

[11] Matthew, *op. cit.*, Fig. 7 on p. 214.

those in which the lemurs live today. In Miocene times the forest belt has shrunk apparently, for the fossil anthropoids are found a little nearer the equator, in Italy, around the Aegean Sea, and in Persia (see Fig. 8).

When we reach Pliocene times the fossil anthropoids are still farther south and are found in northern India and in China. This may very well indicate the limit of the forested region of Pliocene times, though it is

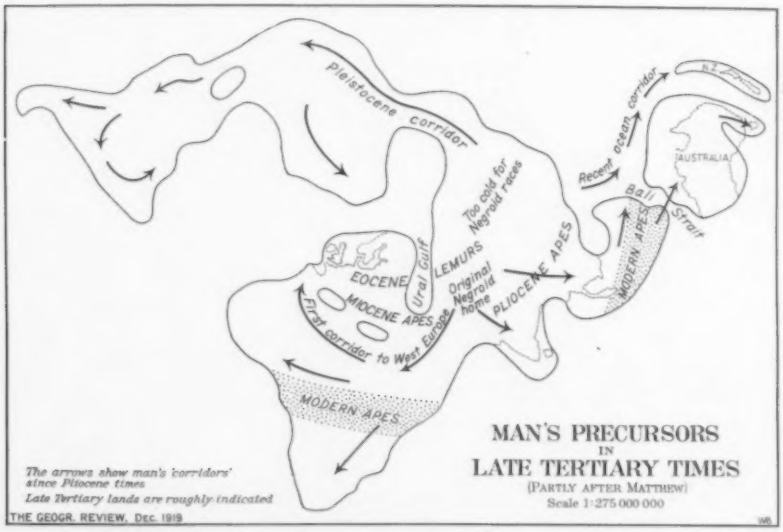


FIG. 8—Generalized map showing the distribution and migration routes of man's precursors in late Tertiary times (based partly on Fig. 7 in W. D. Matthew's "Climate and Evolution"). Scale, 1:275,000,000.

possible it was not as hot and moist there as in the regions where the apes are found today.

However, we are justified in assuming that the region between the Indian Ocean and the Aral Sea (Persia and Turkestan) was forested country with a warm moist climate. We know that the great plateau of Tibet and the Himalaya Mountains were not fully developed till the end of the Pliocene, and probably Asia as a whole was not much above sea level.

SEAT OF MAN'S ORIGIN

From the earlier discussion on Australian climates we may assume that a warming of the earth in these latitudes to 10° F. above its present state would suffice to shift the equatorial rain belt up to the Tropic of Cancer. A broad belt of well-watered forested country would extend north of this, and it is here that it seems likely that man originated. He would develop in the more open park-land country, where his loss of tail would be no handicap and where his powers of locomotion on the surface would be

exercised. Furthermore the more bracing climate on the polar side of the forest zone would make for energy and invention.

So far as we can reconstruct the isotherms these suggestions are permissible. The sea-level temperature of central Persia is about 75° now. If we imagine a rise of 10°, it becomes 85°. If we turn to Figure 2b we see that 85° agrees very well with the polar limit of the tropical rain belt.

With the equatorial rain belt so far to the north, the other belts would move north. The arid belt and polar rain belt would not, however, move so far away from present conditions as the tropical rain belt but would be "squeezed" against the central polar cold. (This is what occurs to some extent at present, for the tropical rain belt migrates much farther than, say, the isotherm of 32° F.)

It must not be supposed, however, that the equator was much hotter in the Pliocene. Probably it was even cooler than in the ice age periods. A redistribution of heat took place, as I shall show later, whereby the climates of the world as a whole alternated from uniform to zonal types.

We may therefore assume that the apes and pithecanthropoids followed the thick forests as they gradually retreated towards the equator. In Pliocene times we may picture the first man as a dweller on the edge of the forests—as are most of the primitive peoples of the world when left to their own devices (see Fig. 8).

Man's Primitive Character

Primitive man was no doubt more or less hairy all over his body and was probably below the present average stature and of a red-brown to black color. His skull was markedly dolichocephalic, and he had pronounced prognathism and black frizzy hair. (Throughout the following discussion consult Table I, p. 306, and Plate V.)

These features are all represented in the Batwa pygmies of Central Africa, who have been described from the region to the northwest of Victoria Nyanza. It is important to notice that here the climate is hot and moist, something like what we postulated for Central Asia in mid-Pliocene times.

Of the primitive characters specified above, the hairy covering is the first to disappear and is not present in allied tribes. The red-brown color is not very constant but depends on the climate. It tends to change to black in one direction and to yellow-brown in the other. The frizzy hair is very persistent, as are the other features. Stature probably varies greatly with environment and food available. In the case of hybrids the primitive hair seems to persist longer than the color, as we see in the Philippine Aeta and the Malay Sakai.

Relics of Primitive Man

With the onset of cooler conditions after the Pliocene, the ancestral home of man probably changed in character as much as any other portion of the

globe. For many thousand years early man wandered in small parties through southern Asia. He would be cut off from Europe by the Ural Sea and would have no reason to move into the more inclement regions to the north. Hence we should expect to find relics of this primitive type chiefly in Africa, in India, and in Australasia.

Here, indeed, is where they occur in the form of the Negritos of Central Africa, in the pygmies of the Andamans and Philippines, in the East Indies and in Papua, and formerly in Tasmania. (Since the Negritos have cephalic indices which range as widely as the Negroes, it is possible that the primitive Negro was co-eval with the Negrito rather than his descendant. But the Negrito in his other characteristics is much the more primitive.)

The Chellean Migration

Before considering the reason for this diversity of habitats, we must discuss the conditions in the Aralo-Persian region just before the First (Günz) Ice Age (cf. Fig. 9). Here a climate better suited for a virile race

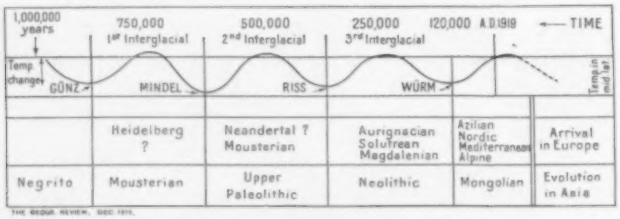


FIG. 9—Generalized diagram correlating the minor climatic cycles and ice ages with the human migrations from Asia to Europe.

had supervened. It was still warm, but not so wet as in the earlier Pliocene time. A race of taller dark dolichocephalic people developed. Their hair was still frizzy and was still flat in cross section.

During the early Pleistocene age—when the first of the great ice ages was commencing—they migrated from their homelands. Their routes were much the same corridors as those used by the Negrito. They drove the latter before them into the less pleasing portions of the world. This series of migrations included the earlier types of Negroes, of whom we find the chief representatives today in Papua and Melanesia and in southern and western Africa.

Some tribes of this migration seem to have reached Europe, probably by way of Morocco and Spain, and have left relics in the form of the early Chellean and Acheulian implements. The earliest skulls of Neandertal (and possibly of Piltdown) may well belong to this people. They have an oval head—much longer from forehead to occiput than from ear to ear—and hence are pronouncedly dolichocephalic.

When the early glacial ages were succeeded by a warm interglacial

period, these tall "longheads" penetrated into France and Britain, where they were contemporaneous with the mammoth.

We must, however, not imagine that all the Chellean people left southern Asia. There were fair lands far removed from the icy mountains of the center. Probably the regions of Persia and Turkestan were much more attractive at that period than they are now. The majority of the Chelleans would remain as near to their old home as possible, learning to overcome their environment, through the long period of the ensuing ice age.

We know that about this time the mammoth crossed the Bering region and entered North America. No doubt it was followed by a few of the outlying Chellean tribes, who slowly spread through the New World into the southern continent, though probably only in small numbers and at a much later date.

The Mousterian Migration

The next migration, thrust out by the Second Ice Age, was the "Mousterian." The Mousterians were also tall "longheads." They were much more expert workers in stone and had developed some primitive industries. They built shelter huts and were not unlike their direct descendants, the Australian aborigines.

It is difficult to decide whether the Australians were earlier or later than the true Negroes. The Veddah evidence would make them later than the Negro. Probably the Negro by stress of competition has developed his relatively high culture, while the isolated Australian has not altered from his original (late) Mousterian culture. In Perak the black Sakai are Negrito-Mongol hybrids. I find no record of true Negroes of the same "horizon" as the Bantu people in the migration toward Australia.

The hair is much less frizzled. It has become wavy or nearly straight and is oval in cross section. The face is still prognathous, the brow ridges are prominent, and the root of the nose is much depressed.

This Paleolithic race is well represented by weapons and skulls from Europe and North Africa, where it was the dominant race before the Hamitic-Iberian migration.

As with all the other primitive races it has been pushed back by the latest peoples. We find that the Mousterian Australian had displaced the Tasmanian. In southern India the late Mousterians are represented by the Veddahs and by some of the Dravidian tribes of the south. They have probably driven south the forerunners of the Nicobar and Andaman pygmies. Their characters and associates appear in the table.

In South America there is little doubt that, in the eastern Brazilian highlands, the Botocudo people are Mousterian. They have the same head index (73) as the Veddah and Australian and the same brow ridge and nasal depression. They build the same "wurley," or shelter, and wear no clothing. The ancient skulls, dug up at Lagoa Santa nearby, are even

TABLE I - MIGRATIONS OF THE HUMAN RACES, PLIOCENE TO RECENT

(Figures in table are cephalic indices)

RACE AND COLOR	AVERAGE CEPHALIC INDEX	AVERAGE ORBITAL INDEX	HAIR	HAIR SECTION	CULTURE	EUROPE	SOUTH AFRICA	NORTH AFRICA	AUSTRALIA	POLYNESIA	MALAYA	ORIGINAL HOME (Caspian-Persian Region)	INDIA	CHINA	EAST SIBERIA	NORTH AMERICA	SOUTH AMERICA
NEGRITO Chocolate to black	70 to 72	80 to 84	Frizzy	Flat	Acheulean?	Too cold?	Hairy Batwa	(Dwarfs of Monuments and Somaliland)	Tasmanian hybrid 74	Fly River Papuan		Originated in Pliocene forests, possibly from Pithecanthropus type.	Mincopi, hybrid with Mongol?	Aeta, hybrid with Mongol	Too cold	Too cold	
NEGRO Red-brown (Black in hot lands)	71 to 73	82 to 85	Frizzy to wavy	Flat to oval	Mousterian	Neanderthal type arrived in early (2nd) interglacial period	Early Bantu 71 Later 73	Early Wolof 69 Guinea Blacks	Australian aboriginal	Fijian hybrid 69 Melanesian 73	Mysore 70	Originated here in First Interglacial Period	Some Kol tribes Veddah		Eskimo hybrids?	Calaveras skull? Mousterian tools Greenland Eskimo hybrid 72	Bleached Botocudo and Caraya of Brazil (like Australian)
HAMITIC - IBERIAN Brown	73 to 76	84	Wavy	Flat to oval	Magdalenian Solutrean Aurignacian	Aurignacian and Solutrean of Central Europe arrived in 3rd Interglacial Some Portuguese	Aurignacian Bushmen (hybrid) and Hottentot Zulu	Fulah (hybrid) Moors	migrants	Moriori?	Ceram 74	Originated here in Second Interglacial Period	Toda 74 Some Hindu	Some Lolo and Miao-tse	Bleached Ainu?	Solutrean of California — Eskimo — Hurons	Solutrean in Argentina Some Brazilian tribes Caingua etc
EARLY ARYAN Olive-brown	76 to 78	86	Wavy	Oval	Late Neolithic Azilian	Arrived after Würm Age Azilian — Bleached Nordics	Hava?	Berbers Semite Arab	No later	Moriori 76 Samoan Maori	Most Dyaks Sikai of Flores	Originated here in Third Interglacial Period	Bengal, Afghan	Moi in south	Ainu 75	Some Algonkians and early Californian	Some Carib tribes Yahgan
LATE ARYAN (SLAV etc.) Olive-white	78 to 82	87	Wavy to Straight	Oval to round	Bronze European	Mediterranean races and some Central Europeans	No later migrants	No later migrants	No later	No later migrants	Javan Sumbawan	Originated after 4th Ice Age Persians 78	Some northern tribes	Japanese Korean North Chinese	Ostiaks	Zuñi Pawnee etc.	Yuracaré? Arawak Early Quechua
EARLY MONGOLIAN (TUNGUS) Pale yellow	82 to 86	·90	Straight	Round	Sumerian *	Alpine races Magyar	No later migrants	No later migrants	No later	No later migrants	Cambodian	Armenian Sumerian *		(Aeta hybrids	Tungus	Navajo Moki Yucatec	Some Quechua — Araucanian
LATE MONGOLIAN (KIRGHIZ) Yellow	86 to 89		Straight	Round		Lapp	No later	No later	No later	No later	Burmese etc.	Kirghiz			Giliak	No later	migrants

* Sumerian culture - perhaps the first town life - was possibly early Mongolian. Thence it soon spread to Semitic people who had a happier environment and so progressed further.

more primitive and represent earlier types of South American Mousterians. They are of lighter color for reasons suggested earlier.

In the later ice ages the climate of the center of migration in Asia was still cooler and moister. Under the influence of these controls the color of the remaining tribes became paler, changing from a red-brown or chocolate to a yellow-brown or tan color. The healthful energy-promoting climate led to a growth of civilization and intellect, which reacted on the cranium. The latter became much less oval (index 76) and more compact. The jaws decreased in size and projected less. The hair also lost its flat section and consequently did not wrinkle but was often wavy or nearly straight.

The Aurignacians

There seems to be a definite break here, between the Lower Paleolithic (Chellean, Mousterian) and Upper Paleolithic peoples, of whom the chief are the Aurignacian, Solutrean, and Magdalenian.

It seems logical to assume that the great change in culture is the outcome of a break in the continuity of descent. In fact we can with great reason place the Second Ice Age between the evolution of these peoples in Asia.

No doubt the early Paleolithic people marched south fleeing before the oncoming cold belts. Some hardier tribes withstood the environment better and reaped their reward in a more virile and intellectual posterity. These reoccupied the Central Asiatic region, on the retreat of the Mindel environment. Some hundreds of thousands of years later the oncoming adverse climate again drove most of these tribes to the south. They followed the old corridor into Africa and so arrived in western Europe in the Third Interglacial Period.

The chief characteristic of the earliest peoples in this migration was their artistic ability. The folk were oval-heads, dark brown or yellow-brown in color, and rather short. They were usually noted for their large buttocks, which are represented in many small models made by these Aurignacian peoples. The Bushmen of South Africa are hybrids who have preserved some of their characters, as Sollas has shown.[12]

Their drawings of reindeer and mammoth are found in the caves of southwestern Europe and could hardly be surpassed by modern draftsmen.

The Solutreans

They also were pushed away to the periphery of the lands in certain areas by a stronger later migration of a people known as Solutreans. Their representatives are found perhaps among the early Eskimos and allied tribes of the Arctic regions.

The characteristic laurel-leaf flints of Solutrean age are found in Argentina, California, and Mexico—where we should expect them, as a glance at the map (Pl. V) shows.

[12] W. J. Sollas: Ancient Hunters and Their Modern Representatives. London, 1911, pp. 252-270.

Many of the later tribes of these peoples wandered into America via the Bering corridor. The Amerinds who now dwell in the northeast have cephalic indices about 76. Such tribes are the early Hurons and some of the Eskimos of Alaska. The short stature of the latter is probably a result of under-nourishment, as in so many other examples.

The Magdalenians

Professor Sollas compares the culture of the Eskimos with the prehistoric Magdalenian culture of France and Britain and shows the identity of many characteristics.[13]

The later peoples of this migration—or perhaps the earliest of the next—were the dark-brown races who are chiefly found in northwestern Africa and the western Mediterranean. They include the Iberians and other peoples who still occupy parts of Spain and Morocco. They seem to have entered Europe via the Gibraltar corridor. But later migrations crossed more directly from Asia to Europe; which may indicate when the Ural "gulf" became a feasible and broad land route. This is shown by the fact that the post-Iberian migrations have not driven the Iberians forward, but rather backward on their old track. This is, indeed, indicated in the map of the migration zones (Pl. V).

In India the dark-brown race with a cephalic index near 76 is represented by many tribes of the Deccan. In the mountain regions of southern China are the Lolo peoples, the Miao-tse, the Chiams, etc., who are of the same migration "horizon" as the Iberians and have certainly very little Mongolian blood in their veins. We know that they withstood the Chinese hordes for many centuries but were finally driven to the less attractive portions of China. Some of these tribes may, however, be a little higher in the ethnological record.

As the cycles advance we find the same general trend in evolution. The head becomes more compact, e. g. spherical, as the brain increases in size. Hence the cephalic index usually increases with the growth of culture. The hair becomes less frizzy and rounder in section. The eyes lie in rounder sockets (see orbital index in Table I). The color changes in a definite order, if we keep in mind the chief abiding place of the race in question.

The Aryan Migration

After the Second Glacial Age the early Neolithic peoples developed in the Aralo-Persian region and were driven south by the Riss glaciation. To this migration I have applied the somewhat ambiguous term "Aryan."

In Europe the migration seems to have included the earliest "Mediterranean" peoples, whose cephalic index was below 78.

[13] Sollas, *op. cit.*, pp. 348-350 and 368-383.

These people moved away under stress of hunger or occasional droughts and constituted the great Neolithic migration. They used polished stone weapons and erected large monoliths, which are scattered all over the world wherever their tribes migrated. These monuments occur very largely in Turkestan and southern Siberia, where the climate does not appear now to be suitable for a large population. They occur all through the north of Africa and through Persia. They are very common in northern India, Korea, Japan, and the East Indies. They are well-known features in North America and along the western coast as far as Chile. They are found even in the remote isles of Polynesia.

These Neolithic tribes followed the footsteps of more primitive peoples. They crossed into America by the same route, probably in the warm period of the Azilian age. It certainly seems more logical to assume an origin for the American Neolithic monuments similar to that of the Old World monuments and executed by allied people moving along the long-established migration route rather than to deny all connection because the links are not at present all complete. I shall return to this point later.

No doubt many of these Neolithic folk settled in large numbers along the eastern coast of Asia. They had a place in the ancestry of the Polynesians and in the Ainu, though the former have undoubtedly some later Mongolian blood also.

The Earliest "White" Races

As regards the central breeding place of the races, we have now reached the period just before the dawn of history. There is no doubt that the climate had become progressively drier in this region though not necessarily less healthy. Primitive irrigation would become a necessity of the settlers, who had taken to agricultural pursuits. This would stimulate invention and the growth of walled villages—just as was the case among the Pueblo Indians of America.

Under the stress of climatic impulse further migrants would wander away and settle in the nearest suitable regions. These wanderers of a pastoral type largely constitute the first so-called white races. Almost certainly they were more of an olive-brown, such as we see in the great majority of the Indo-Aryan races today.

They are found in northern India, in Arabia, and as scattered settlers throughout Burma and western China. Many of the Lolo peoples—the Moi tribes—and many others are fragments of migration of bearded white folk, which have been swamped by later yellow peoples.

In the south of South America it seems probable that the Yahgans are of somewhat similar origin though here the vast flood of later yellow folk has almost obliterated the earlier "white" migrants. However, some of the Tupi races in western Brazil have wavy and even frizzy hair, while the Yuracaré people of the Andes are "of very high stature, their skin being,

it is said, almost as white as that of a European."[14] More data are required to establish this zone, however, in South America.

Nordic, Mediterranean, and Alpine Races

The Fourth Ice Age intervened between the birth of the Azilian, and perhaps of the Stone Monument, peoples and that of the group of people who are now the leaders in world civilization. These are the Nordic, Mediterranean, and Alpine races of Europe and the races akin to them on the same ethnographic horizon.

They all arrived in Europe long after the last (Würm) Ice Age—following far behind the Azilians on the return of the latter to the warming northern lands. They were of an olive color, much like the Greek and Spaniard, the Japanese and Northern Chinese, the Pawnee and Cheyenne Indians of today. All these, indeed, may be cousins and not so far removed from the Britisher as are the primitive Corsican and the Moor.

They followed the immemorial corridors and spread out all over the world, driving the Stone Monument peoples before them. Possibly the transition tribes were the Ainu and Nordics, who have many points in common with the Stone Monument people. All are characterized by long hair; and indeed the ancient Druids of Stonehenge and Brittany may serve as samples of this stage of human evolution.

Deniker states[15] that the extra (third) trochanter, or process on the thigh bone, and the adjacent fossa are characteristic of these people—i. e. the late polished-stone Belgians, the Ainu, and especially the Fuegians. (He does not, however, suggest their kinship on a common ethnological horizon, which seems to me obvious in view of their position.)

Relation of White and Yellow Races

The Ainu people are sufficient in themselves to disprove the fallacy that the white man is a cross between the yellow and black races. Where are the black races which are supposed to have mixed with the yellow to produce the Ainu, who, indeed, are not far from a typical Nordic people?

If the white man is developed from the yellow man, then logically the whole distribution of the races (as shown in the migration map, Pl. V) must equally indicate that the negro is developed from the white man!

As regards the status of the white and yellow races, it seems obvious that the Japanese and Northern Chinese are distant cousins of the chief peoples of Europe, i. e. those living between the Mediterranean and Nordic peoples. These pale-olive peoples of the East have of course some later Mongolian blood in them, as their lack of beard suggests. They are

[14] Joseph Deniker: Les races et les peuples de la terre: Éléments d'anthropologie et d'ethnographie. Paris, 1900, p. 631. Cf. also L. E. Miller: The Yuracaré Indians of Eastern Bolivia. *Geogr. Rev.*, Vol. 4, 1917, pp. 450-464, especially pp. 450-451.

[15] *Ibid.*, pp. 103-105.

apparently free from the dark Iberian blood with which the Europeans of the same horizon are usually endowed. Hence biologically the Japanese cannot be said to be inferior to the European.

Deniker says[16] of the Japanese: "The fine [i. e. higher] type . . . . . is characterized by a tall slim figure, a relative dolichocephaly, elongated face, straight eyes (in the men), ... thin, convex, or straight nose . . . . . The color varies from pale yellow, almost white, to brownish yellow."

We must remember that the evolution of these races has extended through several hundred thousand years. The superiority or inferiority of a race as a whole cannot be determined by what has occurred in the last few hundred years. The idea of the superiority of the white race is natural in view of its present position. But we should remember that the belief was certainly not prevalent in the early Middle Ages, when Mongolian and even American civilization was practically on a level with ours.

Is it not possible that the Sumerian culture in Persia—perhaps the first true civilization—was due to early Mongolians? Petrie speaks[17] of the Sumerians as "shaven people," but the portraits have some appearance of the early Mongolian type.

Culture is largely a result of favorable environment; and by this time the early olive-white races had occupied the best regions and so ultimately developed the highest type of civilization. But they may have been taught by the Sumerian Mongol.

Polynesians and Americans

The Japanese peoples are said to have driven back the Ainu only so late as 600 B. C. No doubt the great Polynesian migrations date from somewhere about the same time. The Polynesians were pushed forth from the southeast of Asia long after navigation was understood. Many of the tribes in the Malay and Burmese regions are closely akin to the Polynesians, as are many of the Indonesian. Proximity to China has resulted in numerous migrations of brachycephalic Mongolians who have nearly swamped the olive peoples in many of the islands of Malaysia.

All round the American Andes we find peoples closely akin to these olive races of the Old World. Data are not readily obtained as to their ethnological coefficients, but we know that they have the olive color, the aquiline nose, and a similar high degree of intelligence. It is not difficult to connect the Indians of North and South America, for Deniker states[18] that the "Inca bone" of the cranium is found chiefly among the ancient Peruvians and the prehistoric dwellers of the Salt River Valley, Arizona,

[16] *Op. cit.*, pp. 450 and 451.

[17] W. M. Flinders Petrie: Eastern Exploration, Past and Future (Lecture at the Royal Institution), London, 1918, p. 67.

[18] Deniker, *op. cit.*, p. 79 (the latter reference based on Washington Gladden: Human Bones of the Hemenway Collection in the United States Army Medical Museum. *Memoirs Natl. Acad. of Sci.*, Vol. 6, pp. 139-286, Washington, D. C., 1893; reference on pp. 187-190).

showing their close affinity. It occurs also in some Europeans, and, though I have not seen the data, I expect that those with the same cephalic index (near 80) will be found to be the possessors of this link with the ancient

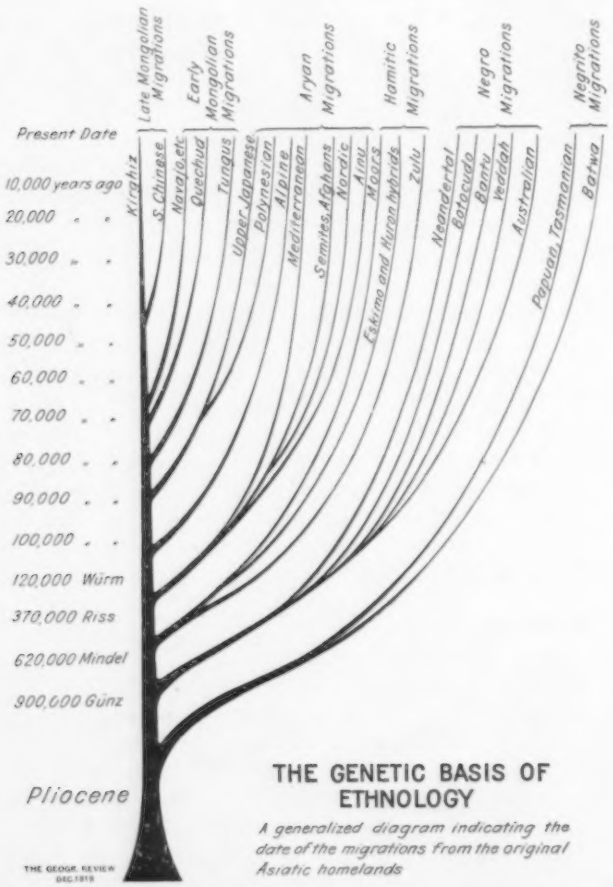
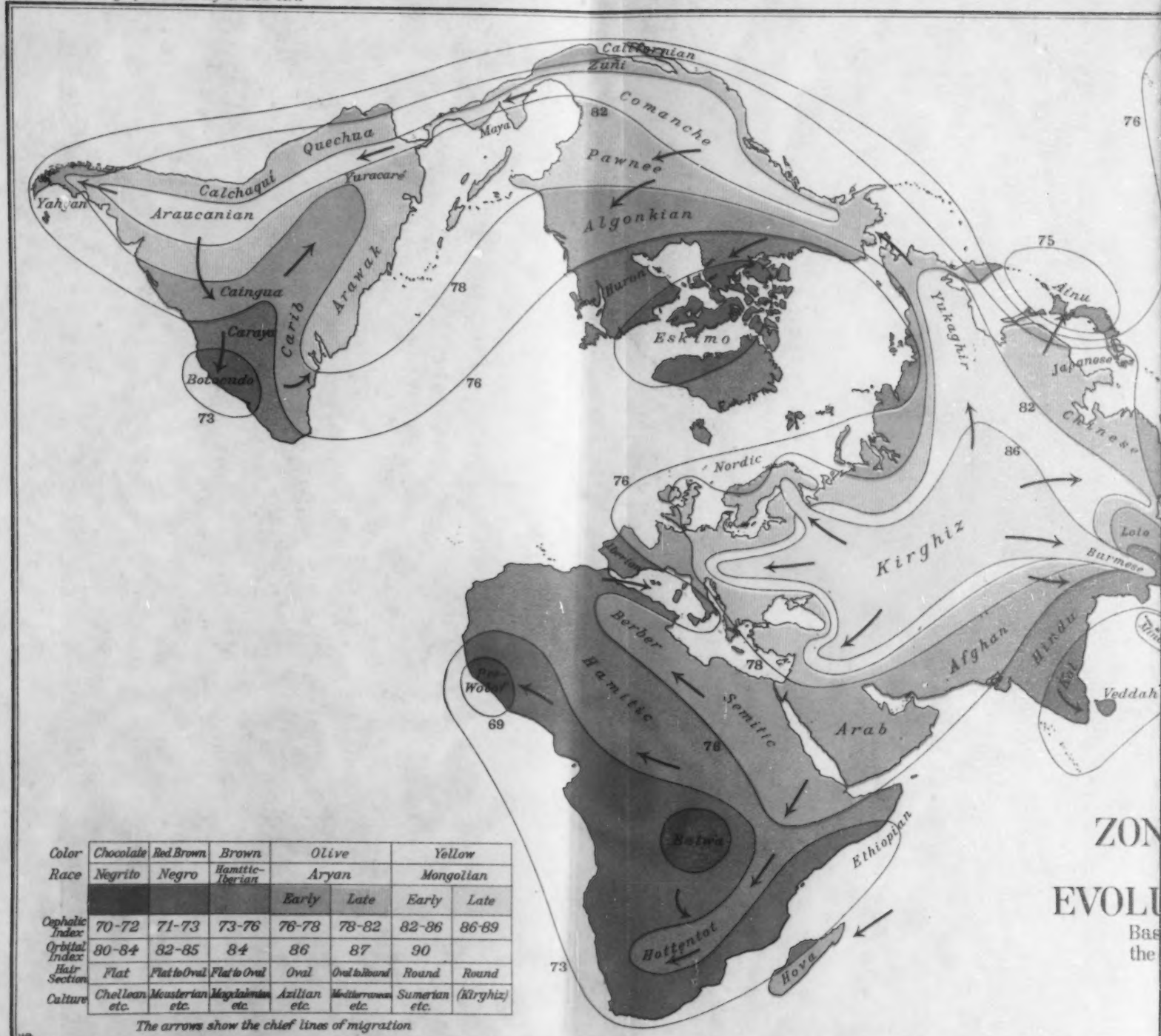


FIG. 10—Generalized diagram indicating the period in the geological time scale of man's migrations from the original Asiatic homelands.

Incas. An analogous distribution probably occurs with regard to the *Os japonicum* of the cheek, i. e. in the Japanese and their equivalents in Europe.

LATER MIGRATIONS FROM ASIA

We have now finished with the Pleistocene ice ages—for we are now living in the Fourth Interglacial Period.



Color	Chocolate	Red Brown	Brown	Olive		Yellow	
Race	Negrito	Negro	Hamitic–Iberian	Aryan		Mongolian	
				Early	Late	Early	Late
Cephalic Index	70-72	71-73	73-76	76-78	78-82	82-86	86-89
Orbital Index	80-84	82-85	84	86	87	90	
Hair Section	Flat	Flat to Oval	Flat to Oval	Oval	Oval to Round	Round	Round
Culture	Chellean etc.	Mousterian etc.	Magdalenian etc.	Azilian etc.	Mediterranean etc.	Sumerian etc.	(Kirghiz)

The arrows show the chief lines of migration

ZON

EVOLU

Bas
the

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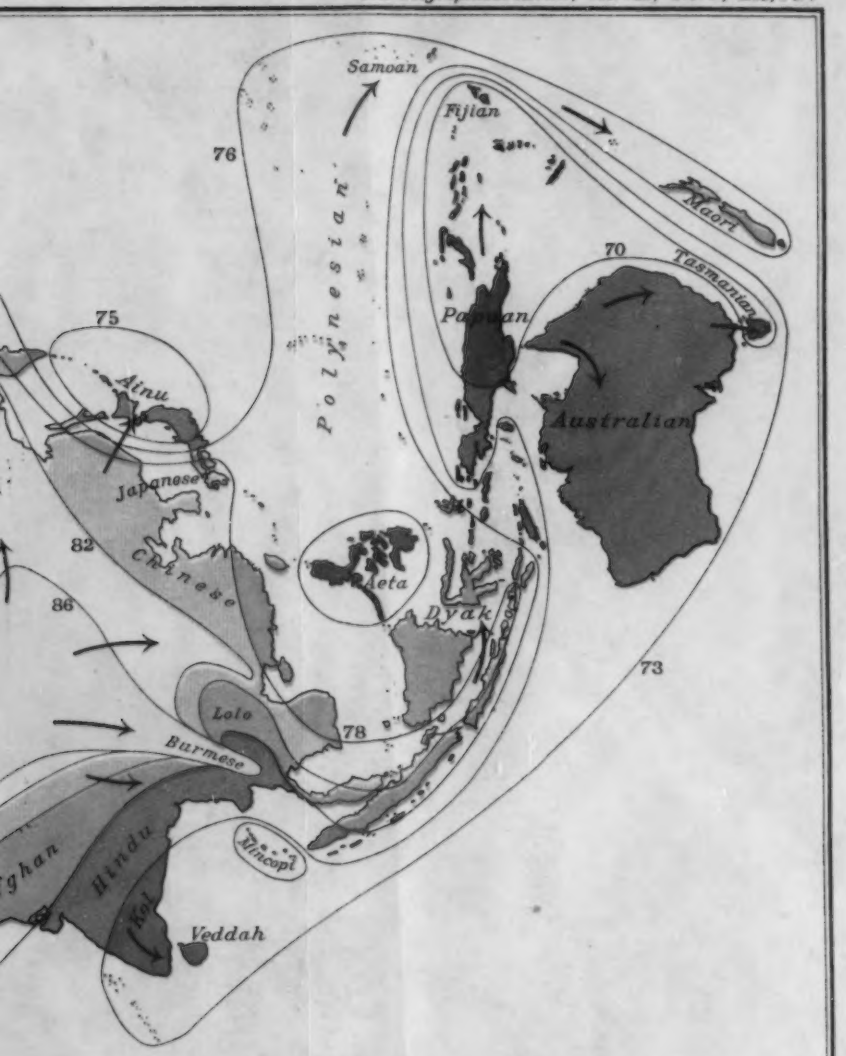
Eskimo
Yukaghir
Nordic
Kirghiz
Afghan
Arab
Semitic
Ethiopian
Hova
86
78
76



ZONES OF MIGRATION
SHOWING THE
EVOLUTION OF THE RACES

Based mainly on the cephalic indices of the most primitive tribes in each region

BY GRIFFITH TAYLOR

Scale 1:100 000 000

Polar zenithal equidistant projection

But the climatic control does not therefore cease to cause migrations. It is, however, *drought* which has caused the later people of Asia to swarm forth from time to time. Huntington has investigated this question very carefully,[19] so that the "pulse of Asia" is now beyond doubt. This pulse was much weaker than the "thrusts" of the ice ages but operated in the same fashion.

Some great period of inclement climate in Central Asia drove out many of the early Asiatic peoples, and they appeared in Europe as the Alpine races and later as the Slavs. These arrived about the dawn of the historical period.

The Huns were true Mongolians, and the Magyars also have a cephalic index about 85 (see Table I). They spread through Europe (via the Urals) between 400 and 500 A. D. In the next century occurred the Avar migration, and in the sixth century that of the Bulgars. Many Slav people came in about 750 A. D., while Mongol Finns reached Flanders in 955.[20]

The African Semitic races made one or two migrations (probably as the result of "thrusts" on their eastern marches). Thus the Arabs reached Gibraltar in 710 and France in 730. A mixed race with some Semitic blood composed the Turkish invasion which approached Constantinople about 1000 A. D.

Early Mongolian Migrations to America

The last migrants to America were some of the earlier Mongols. Deniker states[21] that the Yukaghirs of Verkhoyansk approach very closely to certain northern Amerinds. They moved along the Rocky Mountains and the Andes as before. Down in the far south are the Tehuelches (index 85) with oblique eyes. Some of the Peruvian Quechua tribes are similar. So also are the people of Yucatan and many tribes allied to the Navajos. In all these cases crossing has hidden some of the characters, but the cephalic index always increases as we approach the great corridor of migration.

The British Columbian Indians may very likely be akin to an earlier migration, for their culture (e. g. carvings and canoes) has many affinities with the Maoris. I have no data of their coefficients.[22]

In Asia the Mongols burst through into India and founded the Mogul Empire in the seventeenth century. At a much earlier date, about 3000 B. C., the Mongols drove to the northeast the earlier people of China. This latest type of Mongolian "roundhead"—of whom the Kirghiz are a type—has never apparently reached America. Nor has their environment led them to develop any notable culture.

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[19] Ellsworth Huntington: The Pulse of Asia. Boston, 1907.

[20] W. M. Flinders Petrie: Migrations (The Huxley Lecture for 1906). *Journ. Anthropol. Inst. of Great Britain and Ireland*, Vol. 36, 1906, pp. 189-232; reference on p. 215.

[21] Deniker, *op. cit.*, pp. 431-432.

[22] On the map of North and South America showing cephalic index on p. 302 of Clark Wissler's "The American Indian," New York, 1917, the figures for the British Columbia area are 81 (Puget Sound), 80 (interior plateau: Thompson Indians?), and 83 (Alaska Panhandle: Tlingits).—Edit. Note.

Asiatic Invasions at the Present Time

Even at the present time the same Asiatic invasions occur. The Slav races are driving the Germans to the west, and partly in consequence the Germans were very largely settling in London before the war. The British again are emigrating before the economic pressure of the later races in central Europe.

It may be that the olive-white peoples with a cephalic index from 78 to 83 mark the zenith of the human race, but modern civilization has so short a history and is so obviously the product of a favorable environment that we have no right to assume so.

In Figure 10 I show how this charting of the migration zones affects the genetic "tree" of the human race. If it be accepted, then the accepted schemes of ethnographic classification will obviously need considerable modification.

Part IV

Climatic Cycles in the Geological Record

Temperature Changes in the Geological Past

It is clear from the earlier discussions that the north temperate zone (or mid-latitudes, as they are preferably described) was on the whole cooling during early Tertiary times.

With the Pleistocene we get the extraordinary oscillations in climate shown by the four ice ages and the three interglacial ages. If we take the present mean temperature of central Europe at about 50° F., then we may estimate the corresponding temperatures during earlier epochs as given in the following table. (The temperatures at latitude 30° N. and at the equator have been added for comparison.) These temperatures are based on paleobotanical and other evidence, but are, of course, only the roughest approximations.

TABLE II—Estimated Changes in Temperature, Present to Triassic
(*In degrees Fahrenheit*)

Age	Central Europe; Lat. 50° N.		Region of Ancient Civilizations; about Lat. 30° N.	Equator (suggested)
Present	50	(10° C.)	76	80
Historic	47		72	79
Neolithic	43		68	79
Würm Ice Age	40		65	82
Third Interglacial	52		76	80
Riss Ice Age	37		62	83
Second Interglacial	50		75	79
Mindel Ice Age	35	(Maximum zonal climatic type)	60	84
First Interglacial	52		76	79
Günz Ice Age	40		65	82
Pliocene	65	With some diminishing fluctuations corresponding to the Pleistocene cold periods	76	78
Miocene	70		76	77
Eocene	75		77	77
Cretaceous	76		77	77
Jurassic	76		77	77
Triassic	76	(Uniform climatic type)	77	77

The third column is in accord with the results of marine paleontology. Thus Smith writes[23] that during the Triassic there was "nearly uniform distribution of warm water over a part of the globe." Of the Jurassic Schuchert states[24] there was "a very wide medial warm-water area, embracing the present equatorial *and temperate zones*, with cooler *but not cold water* in polar areas." In the Lower Cretaceous we get some evidence of a *zonal* climate like the present, which did not last long, for the *uniform* climates held sway through Cretaceous and Eocene times (see Figs. 11 and 12).

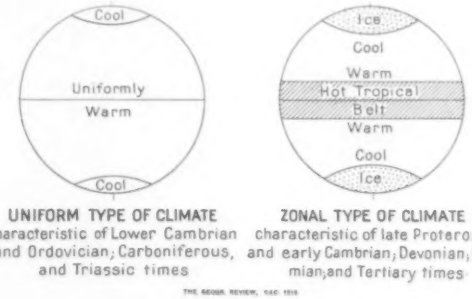

FIG. 11—Diagram illustrating the two types of temperature distribution, uniform and zonal.

It is in the Miocene, however, that the zonal type begins to predominate, and thence it continues to the present. In other words, in the early Tertiary we begin to see premonitions of the oncoming glacial periods in a series of fluctuations which gradually increase in intensity.

It is evident that we have here, but at a very much slower rate, a steady change of climate of the same type that we saw in Pleistocene and Recent times. Instead of alternations from cold to warm for mid-latitudes, we get a change from uniform to zonal which operates over the whole world, as is indisputably shown by the life record (see Fig. 12).

The growth rings of fossil plants corroborate this very remarkably, for they changed greatly in character during the last major cycle, as Schuchert reports.[25]

PRE-TERTIARY CLIMATIC CHANGES

I was therefore led to study the conditions of climatic changes in earlier geological periods (cf. Table III); and I found that the same sequence led up to the preceding ice age, that of the Permian.

David has shown[26] that there were three or four interglacials in the

[23] J. P. Smith: Ancient Portals of the Earth, *Pop. Sci. Monthly*, Vol. 80, 1912, pp. 393-399; reference on p. 398.

[24] Charles Schuchert: Climates of Geologic Time, pp. 265-298 of Ellsworth Huntington's "The Climatic Factor as Illustrated in Arid America," *Carnegie Instn. Publ. No. 192*, Washington, D. C., 1914; reference on p. 281.

[25] *Ibid.*, p. 279.

[26] T. W. Edgeworth David *et al.*: The Geology of the Commonwealth, pp. 241-325 of "The Commonwealth of Australia: Federal Handbook Prepared in Connection with the Eighty-Fourth Meeting of the British Association for the Advancement of Science Held in Australia, August, 1914," Melbourne, (1914); reference on p. 274.

Permian glacial deposits of Australia. Hence the zonal climates occurred then exactly as in the Pleistocene and late Tertiary times.

In Carboniferous times we note exactly the same warming of the environment as we move further from the Permian. This is also coupled with the adoption of a uniform climate throughout most of the world. A cursory glance at Schuchert's masterly summary of past climates[27] will convince the student of the truth of this statement. He writes also:[28] "The world-

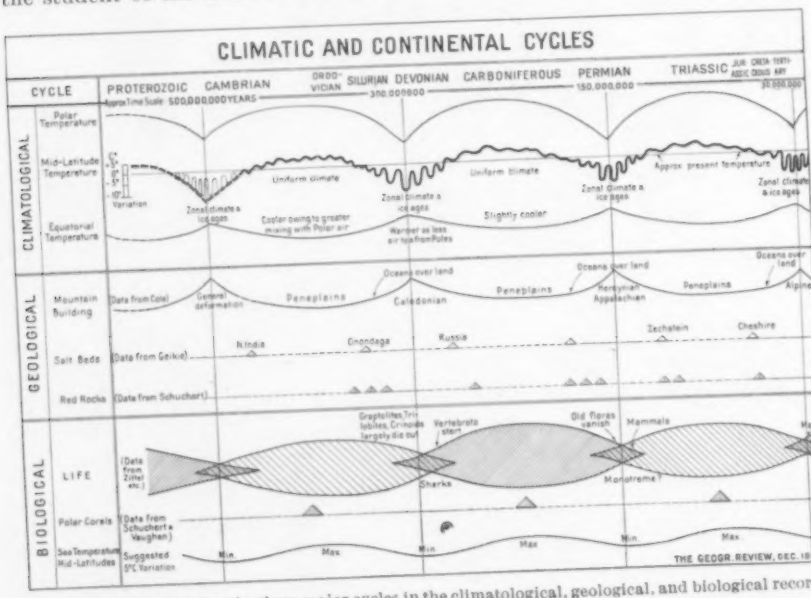

FIG. 12—Diagram showing the three major cycles in the climatological, geological, and biological records.

wide warm-water condition of the late Devonic seas of the northern hemisphere was continued into those of the Lower Carbonic." And, again:[29] "after middle Devonic times the climate of the world was as a rule uniformly warm and more or less humid and remained so to the close of Upper Carbonic time."

Let us now push our inquiry farther back again, using the same authoritative survey as our test. We get the same cycle of conditions.

"The temperatures of air and water had been mild to warm throughout the world since the beginning of Cambric time—there was a marked increase of warmth in the Upper Cambric, and these conditions were maintained through the Ordovicic and the earlier half of the Silurian."[30]

The Silurian closed with a period of zonal climates, culminating in an ice age, which has been recorded from South Africa. At Table Mountain (*fide* Schuchert[31]) are 5,000 feet of quartzites with striated pebbles up to 15 inches long.

27 Work cited in footnote 24. 28 p. 277. 29 p. 278. 30 pp. 276-277. 31 p. 269.

TABLE III - CYCLES IN THE GEOLOGICAL RECORD, FOR NORTH TEMPERATE LANDS CHIEFLY

(Quotations from Schuchert in "The Climatic Factor")

CYCLE		STAGE I Somewhat Zonal Climate Mountain Building Cool, but warmer than present	STAGE II Culmination Ice Ages and Interglacial Periods Mountain Building (Many genera die out) Colder than now, on whole	STAGE III Somewhat Zonal Climate at first Warm, drier	STAGE IV Uniform Climate Red Sands Salt Deposits Warmer, arid	STAGE V Culmination Uniform Climate Peneplains Warmer, moist	STAGE VI Uniform Climate Red Sands Salt Deposits Warm, arid
1st Cycle	RECENT		Interglacial age				
	PLEISTOCENE		Four ice ages Man develops				
	PLIOCENE						
	MIOCENE	(Oaks in Spitsbergen)					
	EOCENE	Early cold cycle San Juan, Colo					
	CRETACEOUS	"In N. Europe no warm seas" Mountains Sierra Nevada etc uplifted					Red sands
	JURASSIC						"Cooler than Trias" Climatic zones begin
	TRIASSIC				Plants scarce (Upper); Red sands, Salt deposits Few marine fauna (Lower)	Subtropical U.S. to Spitsbergen. (Nearly uniform warm water over globe)	
	UPPER PERMIAN		First land animals Appalachian folding ends	Vanishing swamps			
	LOWER PERMIAN		Great ice age (Trials "Australia" S. Africa, India, Brazil				
2nd Cycle	UPPER CARBONIFEROUS	"Coolness and some glaciation ? (Barrell) Appalachian folds start					
	MIDDLE CARBONIFEROUS					Warm in Spitsbergen Coal at Cape Lisburne, Alaska	
	LOWER CARBONIFEROUS					Warm seas and corals U.S. to Alaska	
	UPPER DEVONIAN			Increased "warmth in Upper Devonian ? (Barrell) as compared with Lower Devonian	"Upper Devonian aridity" (Barrell)	Coal at Bear Island	
	LOWER DEVONIAN		(Old Red Sandstone glacial evidence in England ?) "Entire stocks blotted out" Sharks and other Vertebrate plant Mountains and volcanoes in New England Canada				
3rd Cycle	UPPER SILURIAN	"Caledonian Mountains"	5000 feet of glacial deposits in S. Africa harmonize with cold climate "(Barrell) Chiefly apparent in Southern Hemisphere				Arid Climate
	LOWER SILURIAN					Mild and uniform climate "Warmer than Upper Silurian"	
	ORDOVICIAN				Mild and uniform climate Red sands (Schuchert) Reef corals in North		
	UPPER CAMBRIAN			"Markedly warmer than Lower Cambrian."	"Lime habit" came in dominantly, suggestive of warm seas		
	LOWER CAMBRIAN		Some mountain building in E. America and W. Europe				
4th Cycle	UPPER PROTEROZOIC	Greatest ice age in the record ! Australia, Chile, Norway etc Great mountain building					
5th Cycle	MIDDLE PROTEROZOIC	Ice age of earlier cycle probable at Kadapah horizon, India, in Pretoria series, and Torridonian ?					
6th Cycle	LOWER PROTEROZOIC	* * * * * possible at Huronian level ?					

It seems much more than a coincidence that this glacial epoch should be placed just here in the geological record. We must remember that the whole story of Cambrian and Permian ice ages is only a very few years old and that each year sees more and more evidence coming to light in support of their world-wide occurrence. No doubt the Devonian glaciation will be traced in many more regions in the near future.

If we go still farther back we get another great ice age, that of the late Proterozoic (or earliest Cambrian). This also fits into place in the cycles as far as we can judge from our knowledge of the time intervals since the Proterozoic. In the Proterozoic itself there are two early ice ages in all probability. These are indicated in Table III. No doubt they represent two earlier major cycles.

To sum up this aspect of the problem, we find that uniform climates govern the world for long periods of geological time. Then great disturbances ensue which give zonal climates of relatively short interval (say 200,000 years) which culminate in an ice age with marked interglacials. This type slowly passes away, and the world enters into its normal uniform climate again.

The zonal climates and great ice ages occur in late Proterozoic, Devonian, Permian, and late Tertiary times. The three periods of uniform climate occur in late Cambrian and Ordovician, in Carboniferous, and in Triassic times. The change from one to the other is, of course, gradual, as indicated on the graph (Fig. 12).

Periodicity of Warm Uniform Climates

This in itself is an important step to have taken in past climatology, but if we look more closely into the evidence we shall find that our study of Australian climatology will lead us much further.

We saw there that the desert belts migrated back and forth in the interglacial periods. Do they migrate in the oncoming and waning uniform period? There seems no doubt that they do. The zonal changes are passed through quickly but are of the same type as the vastly slower changes during the start and finish of the uniform climatic period.

If we take any given latitude belt, such as from 40° to 60° N., we shall find that it has been affected by the arid belt in greater or lesser degrees in past time. Thus Geikie gives[32] five notable horizons in which salt deposits and salt springs occur. These are the Lower Cambrian deposits of the Salt Range in India, the Onondaga salt beds of Canada, in the early Silurian; the Russian salt beds of the Upper Devonian; the Zechstein of the late Permian; and the Cheshire deposits of late Triassic (see Fig. 12). If we plot these on the graph we find that they occur midway between the ice age and the center of the uniform climate period in each of the cycles. Thus the north temperate lands passed from the cold wet periods of the

[32] Archibald Geikie: Text-book of Geology, London, 1882, pp. 661, 692, 704, 757, 759, 765.

ice ages, through the warm dry periods of the salt deposits, to the warm moister center of the uniform period; and so back through the dry period to the next ice age.

If we plot the red sands, as given by Schuchert[33], these arid deposits occur in almost the same periods as the salt (see the series of symbols in Fig. 12).

Let us now look at the presence of coral reefs in polar waters. Schuchert mentions[34] three notable examples. These occur in the Middle Ordovician from Alaska to Oklahoma, in the Lower Carboniferous, and again in Triassic times. No clearer proof is surely needed of the periodicity of warm uniform climates throughout the world (Fig. 12).

Testimony of the Biological Record

We must remember that at the present time land temperatures vary from +120° F. down to —90° F., a range of 210°. Sea water at the present time has a range from about +80° down to +28° F. At this lower temperature the pack ice effectively protects the water from the cold air, and the lower waters do not freeze. As a consequence polar seas are teeming with life. The floor of the Ross Sea is almost paved with siliceous sponges and swarms with shrimps and diatoms.[35] Hence we should not expect our climatic changes to have anything like so much effect on marine organisms as on land organisms—for the range is only 52° as opposed to 210° even in zonal periods. In the uniform periods probably the seas were almost the same temperature from equator to pole.

Let us now turn to the biological record (Fig. 12, bottom). There are four outstanding periods. The first is the dawn of the Cambrian, which for long years marked the oldest record of fossil life. We now know of many fossils in somewhat older rocks, but there is no doubt that some enormous change in environment affected life then.

At the close of the Silurian we have another critical stage. There were feeble precursors of the vertebrates before the Devonian, but the vast array of sharks and true vertebrate fishes commenced in the Devonian. Some great change blotted out all the graptolites, most of the trilobites, and many families of crinoids about that time also.

At the close of the Carboniferous the land floras changed remarkably, and we may with certainty follow Matthew[36] and place the birth of the mammals in the Permian. Now the first reptiles crawled on the land, and it is surely more than a coincidence that the primitive mammal (the platypus) still maintains his amphibian method of life.

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[33] *Op. cit.*, pp. 273-274.

[34] *Op. cit.*, p. 276 (based on T. W. Vaughan), 277, 280 (based on J. P. Smith).

[35] See "With Scott: The Silver Lining" (1916), where I have discussed this question fairly fully (pp. 74-75 and 83).

[36] Matthew: Climate and Evolution, p. 181.

The close of the Tertiary marks the culminating point in life—the dawn of the human age. No doubt the monkeys flourished in late Tertiary times, but it was the strenuous times of the Pleistocene which picked out the dominant type of mammal and gave to man the proud position which he occupies.

Surely these four stages, in agreement with the four zonal periods, indicate a cyclical type of evolution. The Cambrian is the dawn of an infinite number of new forms; the Devonian marks the birth of the vertebrates; the Permian the birth of the mammals; and the Pliocene and Pleistocene the birth of man.

Testimony of the Geological Record: Periodicity in Mountain Building and Vulcanicity

There remains one more cyclic phenomenon which I have not yet discussed. It has long been noted that the ice ages agreed with the periods of great mountain building (Fig. 12, middle).

If we study Cole's interesting account of the "Growth of Europe,"[37] we find that he specifies three main stages in the building of the continent. In late Silurian and early Devonian times occurred the great Caledonian uplift, which altered the whole shape of western Europe. In Permian times was the Hercynian period, when central Europe was puckered into great east-and-west folds. (This is the American Appalachian period.) In late Tertiary times we have the "Alpine storm," as he terms it, when the central portions of Europe were tossed like sea waves. This started at the end of Mesozoic times and culminated in Pliocene times, when all the great mountains of the world were raised to their present height.

Between these maxima—which coincide absolutely with the zonal-climate periods—there were stages of passivity. Great peneplanation occurred in the Ordovician, Carboniferous, and Triassic. Towards the close of these periods the first tremors of the zonal period were felt. As a result the seas largely invaded the flat continents, and we get the great transgression periods of the Silurian, early Permian, and Cretaceous. These also fit into the cyclic changes.

It would seem to me impossible to deny this periodicity, when the careful world surveys of so many investigators—Schuchert, Geikie, Cole, Zittel, and others—all point the same way.

It is not reasonable to expect every detail in the whole geological record to agree absolutely, for it is not suggested that no other factors operate beyond those here discussed. Vulcanicity is a test case. A world-wide survey will, I am sure, show some such arrangement as the following.

[37] Grenville A. J. Cole: The Growth of Europe (in series: The Home University Library of Modern Knowledge No. 84). London and New York, [1914].

TABLE IV—Periodicity in Mountain Building and Vulcanicity

Periods of great mountain building and major vulcanicity (zonal type)	Late Proterozoic Early Cambrian	Late Silurian Devonian Early Carboniferous	Permian Early Triassic	Late Jurassic Cretaceous Tertiary
Periods of feeble mountain building and minor vulcanicity (uniform type)	Late Cambrian Ordovician Early Silurian	Middle and most of late Carboniferous	Triassic Early Jurassic	

But it is impossible to pick out one small country, such as England or Victoria, and judge by that alone.

A similar example of error from a limited survey would ensue if one were to study the climatic cycle during late Tertiary times merely as it occurred on the Sydney coast. Here the proximity to the sea and general onshore winds have probably given it a fairly uniform rainfall through late Tertiary times. We must study a continent as a whole, and then there is no doubt of the striking seasonal swing in one year or of the marked periodicity through long ages which I have tried to demonstrate in an earlier section.

If we study Australian igneous rocks[38]—as far as one can determine their ages—we find that they occur chiefly in the Pre-Cambrian, Cambrian, and Heathcotian (Cambrian?), that they are less important in the Ordovician and Silurian, and that they are very important in the Lower Devonian. The (Australian) New England and similar rocks may possibly be late Carboniferous; some are placed as Permian. The Triassic is poorly represented. The later Mesozoic and Tertiary agree with my hypothesis.

For Britain Geikie gives the following résumé.[39] Archean and Lower Cambrian show much vulcanicity (as also does Lower Silurian, which does not agree with the curve in Fig. 12). Then Lower Devonian was a time of prolonged activity, and early Carboniferous. Permian times witnessed many vents in Scotland. There were no outbursts in Triassic times; but, with the Tertiary, action begins again.

When we remember that it is very difficult to determine the age of igneous rocks, we may well consider that the relation of vulcanicity to zonal (disturbed) periods has been fairly brought out even in such a small region as Britain.

Part V

The Time Scale

Length of the Geological Periods

It is of course much easier to detect a period in a long lapse of time than to give the absolute value of such a period or cycle in years.

[38] Section on "Igneous Rocks" by T. W. Edgeworth David and E. W. Skeats (pp. 302-314) of work cited in footnote 26.

[39] Archibald Geikie: The Ancient Volcanoes of Great Britain, 2 vols., London, 1897, see Chapter 51.

Until recently geologists had no hope of determining the exact interval which had elapsed since the Proterozoic period. Stratigraphers have made many attempts and have divided the geological record into certain proportions. Thus the appendix to a popular article by Sollas[40] gives the tentative percentages listed in column A in the following table.

TABLE V—Relative and Absolute Length of the Geological Periods

Age	A (per cent)	B (per cent)	C (per cent)	D	E
Cambrian	16	16	33	500,000,000 years ago	300,000,000
Silurian	16	12		430,000,000 " "	
		5			
Devonian		5	33	370,000,000 years ago	150,000,000
Carboniferous	35	20			
Permian		8			
		3			
Mesozoic	25	25	34	30,000,000 (Eocene)	
Tertiary	8	6			
Total	100	100	100	500,000,000 years	300,000,000 years

A slight rearrangement—which can hardly be objected to as far as stratigraphy is concerned—would give us the ratios shown in column B. If these be subdivided in Devonian and Permian times—as the periodic graph demands (see Fig. 12)—then the agreement with the latter is absolute, and we have the geological record separated into three equal cycles by the Devonian and Permian epochs.

Holmes in 1913 in the "Age of the Earth" gives[41] the results of radioactive tests on the breaking down of various minerals. He would seem to favor 30,000,000 years (at least) for the Tertiary period and something over 430,000,000 years since the dawn of the Cambrian. Joly quotes[42] similar figures, indicating about 300,000,000 years as the time interval since the same epoch.

If we agree (as in column B) that the Tertiary occupied 6 per cent of the geological scale and that this is about 30,000,000 years, then the interval since the dawn of the Cambrian is from 300,000,000 to 500,000,000 years on all four scales in the table. This is perhaps as close an estimate as we can expect to make with the incomplete data at our disposal.

Relative Lengths of the Minor and Major Climatic Cycles

As regards the minor cycle (see Fig. 9), comprising the ice age between two interglacials, the evidence in the Pleistocene is somewhat better. In the Antarctic in 1911 we had a great deal of discussion on this very point,

[40] W. J. Sollas in Harmsworth's "History of the World."

[41] Arthur Holmes: The Age of the Earth (in series: Harper's Library of Living Thought), London and New York, 1913, pp. 137-165.

[42] J. Joly: Radioactivity and Geology: An Account of Radioactive Energy on Terrestrial History, New York, 1909, pp. 227-230.

Idem: The Birth-Time of the World, and Other Scientific Essays, London, 1915, pp. 19-29.

when I instanced the graph given by Hess in his book on glaciers.[43] I describe this incident, which occurred when we were literally experiencing an ice age, in my book "With Scott: The Silver Lining."[44]

Later data (such as the chart given by Osborn[45]) seem to show that the Mindel-Riss Interglacial was the coldest and that the post-Riss period was warmer. Hence we have passed the culminating point. If the Pleistocene be taken as occupying 1,000,000 years, as Holmes suggests, then the four ice ages occurred at intervals of about 250,000 years. It follows that we may expect another cold period in about 100,000 years, though the indications are that it will be much milder than the Würm Ice Age.

It may be objected that Osborn does not place these epochs at equal intervals. On the other hand Hess does; and I incline to the latter view for the following reason. Nature in all her grander manifestations seems to be following cyclic laws. If we can detect the indication of a cycle with which many phenomena are in harmony, we shall be amply justified (by many similar discoveries in the past) in adopting the cycle as a most useful instrument for further investigation. As an illustration, I may add that I had realized the probability of interglacials in the Permian and had discussed it with a fellow geologist, who doubted the possibility of detecting them, before I found that Professor David had already described such.[46]

Thus the minor cycles are about 1/800 the length of the major cycles. From the fluctuations which are apparent in the Jurassic and Cretaceous, when colder conditions began to alternate with warmer uniform conditions, we may assume that these short-period cycles occur to a less marked degree in the periods between the major ice ages. In other words the minor cycle seems to be superimposed on the major cycle, but its amplitude increases as the major cycle culminates. However, this is all somewhat speculative and, like the succeeding sections, is only put forward as a suggestion.

Part VI

Suggestions as to the Causes of the Major and Minor Cycles

It has long been noted that mountain-building synchronized with the great ice ages. So far as I know no one has given a reason which explains both phenomena. The ice age does not directly depend on elevation, for the cold epoch affects lowlands also and sends great sheets of ice across the oceans.

I suggest that the common cause may be reached by way of a consideration of the circulation of the atmosphere.

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[43] Hans Hess: Die Gletscher, Brunswick, 1904, p. 383.

[44] pp. 280-281.

[45] H. F. Osborn: Men of the Old Stone Age: Their Environment, Life, and Art, New York, 1916, p. 23.

[46] T. W. Edgeworth David: Evidences of Glacial Action in Australia in Permo-Carboniferous Times, *Quart. Journ. Geol. Soc.*, Vol. 52, 1896, pp. 289-301.

Retardation of Earth's Rotation as Possible Cause, Producing Change in Atmospheric Circulation Resulting in Ice Ages

It will be admitted that high latitudes receive their meager supply of warmth chiefly by means of the poleward air currents. A striking example is seen in the North Atlantic, where the steady warm southwesterly winds and associated drift keep the sea open to Spitsbergen almost all the year round.

If this atmospheric circulation were increased we should get a much greater mixing of polar and equatorial air, and the whole earth would become of a much more uniform temperature. The ice caps would probably vanish; but in compensation the equator would probably be somewhat cooler than at present. This is exactly the condition which has obtained through the greater part of the geological record, as I have shown in an earlier section.

Now, what could cause the circulation of the atmosphere to change in character in this fashion? The simplest answer is to imagine a slight variation in the diurnal rotation of the earth. At present a spot on the equator moves round to the east at the rate of 1,037 miles an hour. As a result the pressure belts lie (in the southern hemisphere) about 35° S. (high pressure) and 65° S. (low pressure). If, however, the dynamic factor, which largely determines where they shall lie, is altered, their position will alter in accord.

If the rotation slightly decreases in velocity, then the belts will be less intense. Thus there will be less warm air driven to the pole and the temperature there will fall greatly. We shall thus tend to get the zonal type of climate, which we are experiencing at present. But a survey of past time shows us that a uniform distribution of heat has been more usual on the whole.

And Producing Crustal Stress and Mountain Building

As stated previously, there is a close connection between mountain building and the periods (late Proterozoic, Devonian, Permian, and Tertiary) when ice ages and the zonal climates obtained.

If the earth's rotation decreased slightly, the bulge at the equator would certainly tend to flatten out. The globe projects here about seven miles as a result of the present rotation of 1,037 miles an hour. I have no data from which to calculate the effect of a diminution of angular velocity of even one mile an hour on the shape of the earth. It is logical to assume that under such circumstances the lines of weakness would be affected by earthquakes and faulting, which, indeed, are prevalent in the present epoch. We should expect the less stable portions near the equator to collapse. There is evidence of this all through Tertiary times in the disappearance of the Antillean, Atlantean, and Malaysian continents. The temperate lands would buckle up—and we find that the major elevations

along the Tertiary mountain ranges are in such latitudes, e. g. the Titicaca and Tibetan plateaus.

That there has been a periodicity in the development of the continents is revealed by Professor Gregory's comments in "The Making of the Earth."[47] He writes: "In the Lower Ordovician an almost complete reversal of land and water occurred," as compared with the present condition. This is just what the present hypothesis demands, for the Lower Ordovician is one of the uniform periods, while the present is a zonal period. At that time North America and Asia were covered by the ocean, and a huge continent connected Africa with Australia and obliterated the Indian Ocean.

Of the next uniform period, i. e. the Carboniferous, Gregory states: "There is even clearer evidence of the recurrence of the Lower Ordovician arrangement, for a continent extended east and west across the southern hemisphere." This continent is known as Gondwana Land.

It seems evident that there is a sort of migration in the continents also. During the uniform periods equatorial lands appear to be very slowly built up, but these disintegrate rapidly (as ridges and fault blocks) during the zonal periods. This occurs especially along the equator, the lands "flowing" toward the higher latitudes. There is obviously much remaining to be explained which is not accounted for by any hypothesis to date.

Under these circumstances the most ancient relics of the crust might be expected to occur in its least disturbed portions. These would probably be in the region between latitudes 45° and 75°. At any rate here occur the chief coigns, or shields, of Archean age, which have remained more or less unaltered throughout the geological record.

It is to be noted that there are no southern lands corresponding to Canada, Russia, or Siberia, except perhaps Patagonia. Hence we are compelled to base our hypothesis almost entirely on northern hemisphere data, as far as these latitudes are concerned.

Explanation of Warming-Up After the Ice Ages

This suggestion—the retardation of the earth's rotation—gives no clue as to the warming-up which seems to follow the ice ages. Probably it is not a general warming so much as a redistribution of heat whereby the world slowly returns to the more normal uniform arrangement of temperature. If we can assume that the heat energy of the world is practically unaltered it may simplify the problem.

It does not seem possible that the earth's rotation accelerates again after the zonal period is over; though, as noted above, the equatorial lands seem to arise periodically. The initial rotation is determined by the conditions governing the birth of the planet, and almost all succeeding influences can only retard that rotation.

[47] J. W. Gregory: The Making of the Earth (in series: The Home University Library of Modern Knowledge No. 54), London and New York, 1912, p. 180.

It is to be noted, however, that the shrinkage of the earth's crust implies a greater speed of rotation (in accord with Kepler's Equal Area Law). Furthermore, we may note that it is possible that the radioactivity of the earth is gradually stimulated by the great deformations of zonal epochs and gradually heats the earth up to its average temperature.

Lest these suggestions appear too speculative, we must remember that the average decrease of terrestrial heat—whatever it may be—has resulted because all these factors have come into equilibrium in the course of aeons and aeons of earth history. The small interval of 300,000,000 years (which is all we have knowledge of in the fossil record) is insignificant compared with the whole life of our planet. Furthermore, we should remember that the maximum temperature change at any one place (at sea level) throughout the time we are considering is only about 15° Centigrade, which, again, is insignificant compared with the range of temperatures in the solar system.

Possible Astronomical Causes of the Earth's Retarded Rotation

What has caused the retardation of the earth, if such has occurred? It would seem to be due to a tidal action which operates in two cycles, one in every 200,000 years and another every 150,000,000 years. This may indicate stellar interference. I hesitate to make any suggestions—for

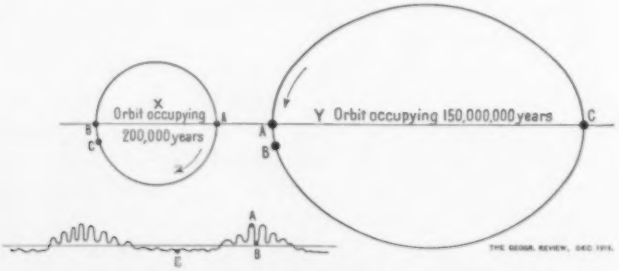

Fig. 13—Diagram illustrating the hypothetical interference of a stellar body Y upon a stellar body X, giving rise (in X) to the cyclic curve shown below to the left.

astronomy lies beyond the province of a physiographer, though it is necessary to include most sciences within the scope of his purview! However, the peculiar form of graph which I illustrate in Figure 13 would result if we assume the following conditions.

Let us imagine a planet or star, X, which has an orbit that it traverses in 200,000 years (see Fig. 13). Let us further postulate another infinitely greater star or planet, Y, with an orbit occupying 150,000,000 years. When Y is at its farthest point from the orbit of X, it will have very little effect on the latter. As Y comes nearer, its effect will grow more marked every 200,000 years as X swings past its "perigee." Finally, when X and Y are

at their nearest points of approach, both cycles of tidal action will be at their maximum. If we imagine that X corresponds to the solar system and that Y corresponds to some unknown star (now 100,000 years away from its nearest position to our system), my meaning may become plain.

It is usually assumed that the solar system is moving through space at the rate of about 11 miles a second. Some astronomers suggest, moreover, that the path is not straight but forms a closed orbit round the Pleiades. Whether this vast celestial revolution has any connection with the periodic cycles which I have endeavored to demonstrate in this paper is a problem which I leave in the hands of the astronomers.

Part VII

Summary

1. The world is at present passing through the Fourth Interglacial Period of the Pleistocene.

2. Temperatures as a whole are slightly warming, as if we had not yet reached the center of the Interglacial.

3. Hence the climatic belts are moving poleward from the equator. The desert region is encroaching on the southern coasts of Australia. The northern littoral is becoming wetter.

4. In the four ice ages of the Pleistocene the converse was true. The southern littoral was wetter than now, and the desert belt was nearer the equator. This "swing" occurs in the northern hemisphere also.

5. The control of historic civilization by the polar march of the belts is very marked, especially around the Mediterranean.

6. A survey of the effect on the Pleistocene history of man shows that there have been four great migrations (due to the four glacial "thrusts") from Central Asia, corresponding to the four earlier races of man—the Negrito, Negro, Hamitic-Iberian, Aryan.

7. These migrations all followed along the chief land routes, or "corridors," and reached Africa and Europe, India, Malay-Australia, and America (e. g. Botocudo and Yahgan).

8. Traces of the Negroid migration are found in South America as well as in other "peninsulas" where they have been "pushed to the wall" by stronger and later races (e. g. Botocudo "Australoids").

9. The last (Würm) ice age thrust out the early Aryan races (olive) not only to India, Europe, and Africa but also into North China and Japan. A number of migrants reached America and are to be traced in the tribes of Brazil as well as in the Algonkians, etc., of North America.

10. Differences in color are connected with the climatic changes in the great Asiatic breeding place (Aralo-Persian region). The hot moist climates produced red-brown races; the cooler moist regions produced olive-brown races, the arid warm regions produced yellow peoples. These races all darken (tan) if they live long in a hot region and bleach (toward white) if they live long in a cold moist region.

11. The ancient cultures can be recognized all over the world and agree with the prehistoric evidence of western Europe and North Africa. Thus the migrations of the "Stone Monument" peoples are identified by the presence, in the skeletal remains of its

members, of an extra trochanter, or process on the thigh bone, in Belgium, Japan, and Patagonia.

12. It seems possible that the last typically yellow races were developed in an unfavorable region and are hence somewhat stunted. The upper-class (pale olive) peoples of China and Japan belong to the same migration as many Europeans. It is quite illogical to say the white man has developed from the yellow. One might just as well derive the negro from the white.

13. Turning now to earlier geological periods we find well-marked ice ages (before the Pleistocene) in the Permian and at the dawn of the Cambrian (late Proterozoic). There was also a third at the end of the Silurian. These four epochs are equidistant in the geological record (as far as evidence goes) and they are perhaps 100,000,000 years apart.

14. There is a well-marked alternation through the ages of periods with sharply differentiated climatic belts (*zonal*) and of periods with almost *uniform* climate throughout most of the world. We are living in a zonal period near the glacial culmination. Warm uniform climates occurred in Ordovician, Carboniferous, and Triassic.

15. The north temperate region passes through a cycle (each 100,000,000 years) from ice age to ice age as follows:

I. Cold wet ice age, mountain building, volcanic action, end of biological era. (There are probably interglacials as in Pleistocene.)
II. Warmer and drier, new genera in great numbers, some mountain building.
III. Warm arid, red sands, salt deposits.
IV. Uniform warm climate, coal and corals in polar regions, great peneplains.
V. Like III.
VI. Like II (except for life types).
VII. Like I; end of era.

16. In the Proterozoic we have evidence of two more cycles, probably of equal period.

17. The last ice age caused the development of man. The Permian is soon followed by the first mammals; the Silurian is followed by the first vertebrates; and the late Proterozoic by the well-known enormous increase in life.

18. As to the *causes of these cycles*, the following suggestions are made:

The alternation of zonal and uniform climates seems to be due to a decrease in the poleward flow of tropical air. This would follow on *retarded rotation* of the earth, for the dynamic circulation would decrease.

19. The coincidence of ice age and mountain building is very significant. The retarded rotation would cause the equatorial bulge to move poleward and induce great folding and volcanic action.

20. The change of the continents from equatorial to temperate belts seems to be indicated in the past record.

21. This theory gives no explanation for the increase in temperature after the ice ages. Possibly it is due to shrinkage in the crust (which would increase rotation), combined with increase in radioactivity (consequent on crumpling, etc.), so that a balance is arrived at not much, if any, colder than before the ice age. (Relatively minute temperature changes are all that is required.) The periodicity may indicate cosmic interference, no doubt affecting the sun also.

THE LAST EXPLORATION OF LIEUTENANT MARQUES DE SOUZA: DIARY OF A JOURNEY ON THE ANANÁZ RIVER, BRAZIL*

PART II

The earlier instalment of the diary of Lieutenant de Souza, published in the preceding number of the Review, *brings the narrative of his difficult journey down to the point where he begins to encounter the long series of falls and rapids that interrupt the Ananáz River midway in its course. His real difficulties now begin. Canoe after canoe is lost, the food supply at times gives out completely, and the Indians become a grave source of danger, finally attacking the party and killing Lieutenant de Souza and others. But for the lucky escape of one of the men who was absent on a hunting trip, the diary of Lieutenant de Souza and the manner of his death would have remained unknown.*

DISASTERS AT THE "NINTH OF APRIL" FALL

April 10. At 6 o'clock we began to move the baggage around the fall on the right bank, just above the smaller fall and just below the large one. There is an abundance of *borrachudo* gnats, which attacked us without mercy. We used the Indian road to transport the canoes. These Indians, according to the information of the Nhambiquaras, are *cocorêo* (very wild) and call themselves Tehêlêpnindê. Everyone who has told us about these Indians has begged me to shoot them on the spot, if they should take hold of the rifle I always carry with me in my tent and should point it and say "pun-pun-pun." From this I concluded that they were very treacherous. At 5 o'clock in the afternoon there happened a thing that we had never expected. We went out in the small boat with the kitchen material in it, and behind it followed my boat from which I made the survey. I had taken three sights and was taking the fourth when Candido, who was in the small boat, warned us to look out as there was a fall. We soon saw him going down with João Peru, and in a moment the boat containing all the cooking utensils, two rifles, two battle axes, and three axes, was full of water. We hardly had time to turn our boat, for the current was tremendous. Thank God, though we continued going down stream, we succeeded in catching hold of limbs of trees and were able, with great difficulty, to stop the boat. At this landing we set up the camp. The two boats behind, which were bringing the supplies, stopped at our call and did not suffer any damage. After some moments poor Candido and João came

* Translated from the Portuguese and published in the *Geographical Review* at the request of the late Colonel Theodore Roosevelt.

along, the former with the sack all wet, and the latter with the oars and a kitchen pan also full of water, tired out by the struggle they had had in the midst of the rapids. We thus lost several essentials: two rifles, the kitchen utensils, three axes, two battle axes, many small kitchen utensils, and the boat. They told us that their boat had got jammed between two rocks and that, with effort, it might be released.

I am very sorry to have lost my best rifles and my tools, for now we have only one ax and four short swords to make boats with. By 7 o'clock at night we had transported to our camp all the baggage of the two boats that stayed behind.

April 11. Early in the morning we went to see if we could save that boat. Fortunately, after breaking our last rope and using our last resource, we succeeded in dragging it by a double cord to the bank of the river. Before this, however, Manguary and João, with great difficulty but with great courage, succeeded in catching hold of the other boats which had not yet capsized. Thank God, we got out the rifles that belonged to Candido, the three axes, and one short sword. We were very glad of this and soon began to transport the canoes around the fall. But, unfortunately, we lost the boat that I was using. Bernardino and Bahia, frightened by the danger which threatened them from the strong current, let go of the boat and succeeded in saving themselves. I soon became resigned to this misfortune and, as I was already tired, ordered breakfast and soon afterward requested Terto to look for a cashew tree, a *guanandy*, or some other timber that was suitable for a boat. The other men continued to open the path, for the Ninth of April Fall continued. At 12:30 I heard shots and was a little apprehensive but soon saw, by their continuation, that the men had found a colony of monkeys. A half hour afterward two men were bringing five enormous *barrigudos*. That was a *fiesta* day.

Increasing Illness and Meager Food

April 12. Yesterday passed without any notable incident. Only I became a little worse, having vomited at night. We moved today to Camp No. 25, a spot above the last fall, which has an average height of two meters; at this place there is an *igarapé* on the left, six meters wide, and one on the right, ten meters wide. The first boat has already been transported. Tomorrow the other two will go, and we shall begin to make one for me. Thank God, I have been better today.

April 14. The men have transported the canoes to a place above the great fall, and my canoe is already dug out. Not until after we have finished it shall we transport it below the fall. I am very eager to continue the trip, for the men, besides being weak and working constantly in the sun and rain, are ill.

Today the number of sick men has increased; there are three: Victorino, Manguary, and Bahia. The last-named is completely prostrated. There

are moments in which, if I were weak-minded, I should lose courage. What gives me most care is the lack of food. In the other camp we killed some monkeys, but after that, nothing.

Breakfast and dinner: *farinha* and rice. Today Victorino went fishing below the falls; but the fish merely approached the hook and then darted away. Fortunately Candido killed today a *mutum*, which served for a dinner for ten men, and one *barrigudo* monkey, which will serve for our breakfast tomorrow. I only pray God that he will give me health to continue the voyage. There is not a single man that has not been sick; and we continue on without knowing where we are going. I wonder if we shall ever reach the Madeira.

April 15. Fortunately tomorrow we shall finish the boat. There remains only the work of transporting it below the fall and of making five oars. I think that on the 17th we shall set out. Today one more on the sick list: the old master workman, Terto, who, although he is sixty-two years old, is worth more than many young men. Victorino is worse and also Manguary. My God, what a situation this is! To see the men sick without resources! Day by day I pray God that I may get to the Madeira as soon as possible, in order to go on home and leave forever this life of the "Wandering Jew." I have experienced everything and can now form a true idea of this wilderness life. Only one who finds himself in my position is able to calculate the enormous difficulties that are constantly arising and that have to be overcome, under the penalty of losing one's life.

April 16. The men continue ill, while the boat will only be ready tomorrow. Victorino and Manguary are better. God grant that they may all be well tomorrow so that we may transport the canoes. Today João and Candido went hunting and succeeded better than yesterday, for they brought in a pig. They found a great Brazil-nut grove but not a single nut. There were heaps of hulls under every tree, a proof that our kinsfolk [i. e. Indians] were the despoilers. When we found the *tocarys*, we were more contented, because that is good food.

Reducing the Baggage

April 17. The boat was made ready. It is as infirm as the master workman Terto. Indeed, what shall we do? We have to accept things as they are and not as they ought to be. I shall have to reduce the baggage. With the data I have, I have just calculated how long it will take us to get to the Madeira. It will take, if we are fortunate, one month. I have been eager to get there by the 22nd of May. We shall see. I shall consider myself very fortunate if I succeed. Thus I shall be able to get to Manáos before the 10th of June. On the 3rd of July, God willing, I shall dine with my people. As it is the birthday of my brother Edward, it will be a great day, for, if Caio comes, we shall have a family reunion. My stomach trouble is worse. I haven't been well all day, and that itch has troubled me a great deal.

April 18. We have been nine days at these falls without the possibility of going on with the voyage. In the first boat wreck we lost the kitchen utensils and other small articles, saving the boat. In the second we lost one boat and four oars. Fortunately I think today is the last day that we stay in this camp, for the men are better and this morning are transporting the canoes while Master Terto is making oars. We are going to reduce our baggage considerably at this point, first abandoning the awning, which occupies space and weighs a great deal. Of our supplies only a little remains. We only have *farinha* enough to last till we find other resources. Coffee we have in abundance. We shall abandon sixteen kilogram cans. Of rice we have four cans, which will last for eighteen meals, and seven kilos of sugar. This is what we have for our voyage.

The Plague of Insects

If we find more falls like this one, we shall be unlucky, and, in that case, it will take us longer to get to the Madeira. I do not know, O God, how we shall get there. I am not well and, besides being weak and unable to walk, tire very easily. I have spent these days under my mosquito net, owing to the attacks of those terrible *borrachudo* gnats. The men go with their feet all wrapped up in rags and their heads covered with a cloth through which you see only the eyes.

This is a horrible thing. From our first camp to this one we have been persecuted by a thousand varieties of mosquitoes, *carapanás, motucas, carrapatos* (ticks), *cupins* (poisonous ants), *mucuins,* bees, ants, etc. What a terrible plague! We nearly finished the transportation of the canoes. Only the *Minas Geraes* robbed me today of much time. I shall see if tomorrow by midday I can transport the baggage to the landing place where the canoes are and if Master Terto will give me two more oars by that time for the trip. I desire to be well rid of this waterfall, and of its hoarse roar. Today is Sunday.

Loss of Boats

April 20. I thought I would move the camp yesterday and go on with the voyage. The baggage was already transported, my awning reduced to half, and indeed everything was ready. I only waited for the two boats to be taken over a small part of the falls, and receive the baggage. The two boats, lashed together, were being towed with a rope; but, behold, water was getting into the small one through a punctured place, and the force of the current, which was very great, would not allow the men to pull it to shore with the rope. The moment was a critical one. The rope broke and the boats, together, were swept over the falls.

The men were saved, but the boats got between the stones, and, although we made desperate efforts to save them, all was in vain. Soon afterward we began to make a raft of *buritys,* but this morning we saw it would not

do. Then Master Terto went with the three men to find a cashew for another boat. Up to 8 o'clock at night the man has not returned, as it was agreed he should, to inform me that a tree had been found. Evidently they have walked the woods all day without success. God knows they may have to spend tomorrow without success. It would seem impossible for me to have lost three boats at one waterfall. My situation is a very serious one, and it becomes necessary to act with calm and do nothing with precipitation, under penalty of a grave disaster. What will become of us?

Impatience at Delay

April 21. What a horrible situation mine is! To desire, to be under imperious necessity to get on down the river as fast as possible, both on account of our health and on account of the scarcity of the supplies, and not to be able to do so for lack of boats, is a most distressing situation, and to endure it one must have great courage.

Not a single moment passes that I do not think of our condition. I wake up from sleep frequently, always thinking about the same thing. I make a thousand suppositions, at times absurd ones; but, thank God, I do not lose courage. Let us wait for the messenger that Master Terto was to send, and we shall then know what is to be done.—10 P. M. Laurindo came a short while ago to inform me that they had found a cashew 15 palms (10 feet) in circumference, sufficient to make a very large boat. Near this one there are others, 12 palms around. The baggage has already been transported to a place opposite the cashew tree. *Farinha* is the only provision we have. If we have no more delays at falls and if we are lucky with our health, I think we shall not get to the Madeira before the end of May or the beginning of June.

I imagine how my mother and brothers must be distressed at not receiving any news from me in May. What could I do? No one is in a greater hurry than I to get to Manáos, for I fear my health will get worse. I shall put forth every effort and hope God will grant me success.

A New Boat Built, Lost, and Recovered

April 24. We moved camp on the 22nd. On the 21st Master Tertuliano, with the men, cut down six cashews and found them all hollow. Happily on the morning of the 22nd, they found one, 16½ palms in circumference, that was sound. The canoe is nearly ready and is 35 palms long and 4 palms wide. The men are in a pitiful state. Our food is *farinha* with *patauá*. I have three hunters, and at times they bring in only a *jacú-tinga* or an *urú*, as today. Sometimes I feed on *farinha* and coffee till the afternoon. My God, what a horrible life! Besides this, the men are weak, covered with sores, and sick. Only God knows how I am. I fear some complication of the bowels.

April 25. The men took courage today from a visit of *barrigudos* to the place where the boat lies. Five of these monkeys were killed on this occasion by João, Aristoteles, and Bernardino. This means we shall have meat for breakfast on the 27th. Today a passing incident took place that gave us some concern. In the morning I sent Candido, João, and Aristoteles (Laurindo) hunting below our camp. The other men having passed the night here, I went with them early to the place where the boat is being made. On arriving there we discover the *barrigudos,* and Bernardino, after seven shots, brings one down. The hunters immediately supposed we were shooting the monkeys and came in the direction of our shots, leaving Candido with their boat. As his *camaradas* delayed in returning, he too came over to us, leaving the boat tied. An hour after he returned and found the boat had disappeared. It had gone down the river. At this point Aristoteles and João came and gave me notice of the incident. God knows how I felt.

Was it possible I should have to delay here longer to build another boat? I did not rest till, an hour later, they brought me the lost boat. What moments one passes in this kind of life!

Numerous Shoals and Falls

April 30. On the 27th I camped in the "Port of the Large Boat." The boat was got ready on the 28th; it carried all of us and all the baggage. On the 29th we set out at 3 o'clock. After traveling forty minutes, we had passed three shoals and had seen two others and one fall below us. On the 30th, after transporting the canoes, we carried the baggage to a place below the fall. This work was ended by 4 o'clock, and soon afterward it began to rain hard.

May 1. 9 A. M. Camp No. 28. I went out at 7:30. After rowing half an hour we heard the roaring of a waterfall and, for precaution, I sent a man ahead to look it over. This was at 8 o'clock, and before 9 I had learned of the existence of two falls, making it impossible to navigate here. We tied up on the left bank, where there is a little open field easy of access. We carried the baggage there and set up the camp on a beach just below the second fall, which is 1½ to 2 meters high. The river is broad, and the spot is very pretty. We expected to continue the trip, but it was impossible. The men fortunately succeeded in landing the canoes above the second fall, and tomorrow we shall undertake to move them overland. It seems almost incredible that since April 10 we have not traveled two hours a day. We have shoals, rapids, and now falls, in quick succession. When shall we end this interminable struggle? I wonder if we shall find more falls after these two.

May 2. Not till afternoon did we succeed, with much labor, in transporting the two boats around the falls. We hope to set out early, to see

if, perchance, we may travel one or two hours. I suspect we are about to come to a high fall, for there have been no fish. When will that joyful day come when we shall have ended this horrid trip?

May 3. We began our activity at 4 o'clock in the morning and at 5:30 we began the voyage. All were hopeful of not meeting any more falls (the land being flat) for the rest of the day. But lo! at 8 o'clock we were halting in order to explore the river ahead of us, for we heard the roar of rapids and falls. At 9 o'clock I was informed that the men had walked more than a kilometer along a succession of falls and cataracts.

Transporting Baggage and Boats Around Falls

We then went into a side arm of the river and unloaded the boats. Not satisfied, I sent João to explore the river, while the men transported the baggage below. At 12:30 the men returned, and João also at 1 o'clock. He told me that the whole region was full of falls; that there was a great fall, 10 meters high, farther down; and that he heard the roar of still other falls below. At 4 o'clock the baggage was in our Camp No. 29, and the men had found, lower down, an *igarapé* 10 meters broad. What shall we do with our boats? Shall we make others and leave these? We will decide tomorrow. Today Candido and João killed thirteen *jacú-tingas*.

May 4. Camp No. 30. We moved to this camping place just below the great fall and on the left bank of the river. Our blazed path runs along the river, and one may see now and then picturesque and most beautiful spots. I have not seen the great fall yet, because, when I got here, my legs had about given out and were aching. João went as far as the last shallows, nearly a kilometer from here. From there, after examining everything, he went on down the river, which improves; for no more noise of falls is heard, and the water runs slowly. Tomorrow we shall begin the transportation of the boats through the falls. I expect I shall lose them, for the passes are very difficult, and there are sections over which they cannot be carried on land because of the rocks and the nature of the ground. God only knows when we shall get away from this place. I judge that these last breaks are spurs of the Serra do Norte; if so, the river will grow better, and we shall finish our painful voyage in a little while.

Discouragement in the Camp

May 5. We took the boats as far as Camp No. 29 near the first fall; we expect to carry them by land tomorrow, and, as there is a great deal to be done, we may stay here several days. Food is scarce, and the men have become discouraged, for we had not found a single *patauá* nor a Brazil nut. Today, however, Candido, João, and Manguary found an abundance—enough to take their breath away.

Today at 12:30 Master Terto came to the camp in discouragement with a cowardly suggestion that we abandon the boats and make new ones of

cashew or chestnut. I had less than my usual patience, for the adversities of this exploring life are extreme. I told him to go back and transport the boats even though it should take fifteen days, as he thought it would, to put them below the great fall. I continue ill; my abdomen is terribly swollen, hard, and sore; my legs are weak, and there is a kind of numbness in my whole body.

How many efforts I have made to hasten my trip! And all nearly in vain. One has to have great resignation and much courage not to give up.

Shooting the Boat Over the Fall

May 6. Early today the men went on ahead with my orders to begin the transportation of the boats, to have a good start by the time I arrived. I ate some nuts and *farinha*, had coffee, and went after them. On arriving at the fall near Camp No. 29 to my amazement I saw that Manguary in the prow of the large boat was descending the little fall. A little afterward he dashed over and, still in the prow of the boat, ran aground just above the great fall. Phlegmatically he stood looking over the big fall with the indifference of one who might simply calculate its height and say to the river, "Now come on, float the boat, and take it down the tumble." After fifteen minutes it dashes over, sinking and breaking—the rope at the prow was secure to the right bank of the channel. When it submerged he loosened the rope, let the boat go farther down, and tied it. Then he leaps into the full current, dives, and succeeds in descending with the boat till the rope is very taut. A half-hour afterward we were bailing out the boat on the left bank, where I and the men were standing. Afterward he and Aristoteles said to me they were going to descend the other fall of the channel in order to be just above the second cataract. I considered it foolish but, as they assured me there was no danger, I yielded.

At 3:30 the boat was on the right bank, run aground, near the entrance of the second cataract. The two went across the river, and tomorrow we hope to be favored again by this breeze that blows good fortune. Perhaps tomorrow the boats will be below the last and greatest of the cataracts. I shall give thanks to God if we are successful in this last crossing, for I am anxious to go ahead and I continue ill. My legs are worse; I am not able to walk fifty meters without getting tired. If I go ahead, it is by holding on to bushes and limbs of trees. When shall I be with my people? Oh, how much have I thought about them! and how many air castles have I built! This is the last time I will leave my family and throw myself into risky undertakings like this.

Fever made me today one of its "rare" visits but did not leave me prostrated as formerly. In the morning I went out with the men to draw out the big boat that had been submerged among the rocks of a little cataract. I felt ill and returned to the camp a little while afterward discouraged from seeing that it was difficult to get the boat out and that a delay might be necessary.

At 10 o'clock Manguary arrived and informed me that, after a great struggle, they had hauled down the boat that was at the falls just above our camp. I was very much gratified. At 3 o'clock it was below the landing at the side of the other. Tomorrow we shall make some oars, for we have only three. Today we had no game; what came to our aid was the nuts and the *patauá*.

Reflections

Only one like myself, isolated and alone in the world, without a single friend to whom to confide what I feel, can fully understand this page of intimacies. I am entirely cut off from everything, my supplies are scarce, and I am ill, constantly suffering, and facing ever-increasing difficulties. Indeed, obstacles rise up at every step, impeding the continuation of this afflicting voyage. And to think we have not made half the distance yet. Oh, how sad is our situation and especially mine! One who, like myself, behind an apparent indifference, idolizes his family and friends, cannot, in this wilderness of the Brazilian west, keep from shedding some tears—tears of homesickness, tears apprehensive of the health and happiness of his own. Who is it that would not, like me, shed such tears? And furthermore, who is there that would not think of the most intimate facts of his home? Constantly I imagine myself there. Today, for instance, is Sunday, the day of rest. In the morning I seem to see my mother and the girls getting ready for mass and Edward and Henry going to the bath; after mass the customary chat at the front door. Indeed it would be irksome to enumerate everything.

Breakfast, the luncheon, the afternoon dinner—all these scenes pass before my eyes as if I were seeing motion pictures.

And . . . even Dr. Angelino awaiting Monsenhór Marinho. These are the scenes that contribute to make my eyes shed tears, which glide burning, one after another, down my face.

What I have said does not denote a weakness of soul; it is not fear. Though sick, and the sickest of all the party, I am the most cheerful and from time to time speak words of enthusiasm to the men or make a joke that disciplines somebody, and I always seek to encourage them to go on with the journey.

Clearings and Vestiges of Indians

May 9. Owing to the lack of oars we did not leave today. Candido, while hunting today, came up with eight clearings on the left bank of the *igarapé* near its headwaters. Two large ones were in the center, and the others around them. They were made by brute force and only last year. We have also found old vestiges of Indians, and I am glad of this. I pray God I may not even see them.

May 10. Camp No. 31. Although fever visited me early today, we began the work of transporting the baggage from the boats. We went out

at 4:30, and at 5:00 we passed on an island the last shoals in this long section full of falls. Tomorrow we shall transport the baggage and the boats. I wonder if we shall travel a whole day without meeting any falls?

May 11. We traveled today without interruption from 7 o'clock to 10, when we twice had to transship our cargo. At 5 P. M. we set out from the last shoal (second transshipment), and at 5:15 we stopped above another to begin our perpetual struggle again in the morning. Today we have made the greatest distance since April 9; we have gone 20 kilometers. We have had a (successful) hunt, thank God! Today we got two little *piaus* and a big fish . . . . . Assuredly there are great falls below, which prevent the fish from coming up the river. In this camp there is a drinking place which attracts deer and tapir such as I did not suspect existed. It must be visited by many of these beasts. One hundred meters in the interior João encountered eight Indian huts made the past year. Of them all only one was made of the *assahy* leaf, the others of the *pacoba* leaf. At the thirtieth position that we fixed we encountered old remains of our kinsfolk [i. e. Indians] and among them a tree of 40 centimeters diameter which they had cut down with a stone ax for gathering honey.

Frequent Rapids and Transshipments

May 12. Camp No. 33. At 7 o'clock we transported cargo by land and set out. Passed six shoals and a little rapid with a fall of 5½ meters. Transshipped four times; at 4 P. M. passed a shoal and immediately saw another large one, but a channel gave us passage. Thus we avoided it, although the passage was difficult. After the crossing a heavy shower fell, and, as it was very dark and the river was full of stones, we landed all wet. We finished our meal at 8:30. Today we killed only a *bigua!*

May 13. Set out at 6:30 and at 6:15[?] landed below a great pool where the river has a width of 200-250 meters. Passed by sixteen shoals and two falls, the first 1.50 meters high, the second 0.6 meter. Transported the cargo twice, the second time at 4:30, at which hour we breakfasted. Calculated distance traveled about 24 kilometers.

May 14. Set out at 6:30; at 7:15 first rapid; carried cargo over land. When the big boat was about loaded we heard João shouting for us to catch the canoe he had lost in the rapids. At that instant I saw it pass, prow up in the air. Immediately Manguary, Terto, Bahia, Bernardino, and Aristoteles were out to the rescue, rowing the big boat. What an hour I passed! I thanked God when they turned up bringing with them the runaway.

The First Affluent of the Ananáz

We set out at 9:30, and at 11:30, below a great shoal on the right bank, we had the surprise so greatly hoped for; we saw the first river emptying into the Ananáz, about 25 meters wide more or less. Directly below, we

breakfasted on an island and delayed in order to stretch the tents and dry the wet supplies.

At 1:15 I went out, and at 3:20 we stopped to transport the baggage at some shoals. At 4:30 we set out and at 5:00, after hearing a roar of a fall, we landed and passed the night in our Camp No. 35. I sent men by land to explore and learned of the existence of three falls and large shoals. We shall see tomorrow what we can do. Today we saw new signs of kinsfolk.

May 15. Camp No. 36. Soon after daybreak we began to work. We went down half a kilometer and tied up to the left bank, transporting the baggage soon after. The land is very irregular and dangerous. We easily transported the baggage through the marginal channels. The first, though only half a meter deep, was the most dangerous, and the last, which was near 1.30 meters deep, was better. At 12:30, having breakfasted, we set out, thanking God we had passed this section, so full of falls, without trouble. At 1:30 we came upon another fall. After we had carried the baggage along the bank, the boat easily descended the stream, and at 3 o'clock we set out.

Living on a Diet of Nuts

As we had nothing for dinner, at 3:50 we stopped in a small nut grove, and, although we made thorough search, we gathered only half a sack of nuts, of which two-thirds were spoiled. At 4:30 we left and soon stopped in a large nut grove, where we supplied ourselves with nuts for dinner. We put up just opposite a good clearing, and now at 8 o'clock the men are all busy wrestling with a dinner. Raw nuts, baked nuts, stewed nuts, grated nuts, nut porridge, and nut milk—indeed today it is nuts in every style. There is no sign of bait for fishing. My dinner consists of a *farofa* of grated nuts, *farinha* roasted, and coffee. We have recently been little visited by the *borrachudo* gnats; but the purple butterflies and, at night, the ants and *cupíns* will not leave us. The plague always! . . . .

May 16. Camp No. 37. This endless series of falls continues still. We transported the baggage and passed around three falls, the two highest reaching a height of 2 to 2½ meters. We have passed two other falls and five shoals. We hardly get away from one before we hear the roar of another. Today we put up just below a cataract 2½ meters high on a side stream. The large boat remains to be taken over tomorrow. We did not have time today.

We are feeding on *farinha* and nuts, and this fare has done me much harm. I have tightened my belt a great deal. We killed nothing today.

The Falls Become More Difficult

May 17. Camp No. 38. Not until midday did we leave Camp No. 37 after we had taken the large boat over a little side fall. We traveled only

30 minutes. After this little voyage, in which we passed two shoals, we were obliged to halt again just above a great fall, more than 8 meters high. We examined the land and verified the impossibility of transporting the boats either by land or by water, for the land also is very irregular. It is a mountain range, which the river cuts through, the banks being 10.35 meters high. Only by the help of God shall we be able to save our boats. The small one with great risk and difficulty may pass through the falls of a side stream, but the large one will not. So we have decided to let it go tomorrow over the great fall, there being a probability of saving it if it does not break in falling. If it does not break it should stop in a large pool where Manguary and Aristoteles will stand to catch it and float it to the right bank.

Our situation is precarious, for we have had no game nor fish for three days, and our *farinha* is reduced to a small quantity. Tonight Victorino went fishing and caught nothing. Brazil nuts are our principal food, although we are already suffering from having eaten them. I have grown worse, for my bowels are very sore and badly swollen. We are compelled to resign ourselves to staying here eight or ten days more! I can imagine how mother and the girls are looking for me in May! Not till June or July shall I be able to get to Manáos, but . . . . God is great and is able to be moved to pity by our situation.

May 18. Here at Camp No. 38 we shall remain a good while longer. All hope of saving our canoes has gone. Our last one was soon full of water and was caught between two rocks and cannot be extricated. The small one remained above the fall; it absolutely will not pass. We shall begin to make new ones today. The worst is that we have nothing to eat. Still God is great and will not forsake us. Victorino succeeded in catching seven fish, and the five men who went hunting brought in two birds. Master Terto did not find cashew trees for the boats. Tomorrow we shall avail ourselves of our last resort, which is to save at least the small boat.

May 19. In spite of the rain we started early on the task of transporting the small boat. The ground is very hilly, and it was very difficult to drag the boat on land, for the rope was rotten and broke three times. We had to give up this rope and use a roll of American line, which, being too small, we doubled four times. Fortunately, with much effort, by 3 o'clock we had the boat out of danger in our camp.

Safe Passage of the Boats

At 3.30 we made an effort to save the large boat, which the men had thought lost. Thank God, by 5 o'clock we had succeeded in getting it out of the water and drawing it on land at an island. Maybe we can save it. How everything changes from one moment to another!

We judged the small boat was lost; but I inspired the men with enthusiasm, and, behold, it was saved. Now what we lack is food, for we

have not had any game. Even the nuts gave out today at dinner. I only pray God for help, so we may set out tomorrow and find something on the way, for we have nothing.

May 20. Thank God, by 10 o'clock we had rescued the large boat, but it almost cost us the life of a companion.

After passing the flagstones, Manguary, Aristoteles, and Laurindo, with wonderful skill, got into her, and the boat, carried forward by the great force of the water in a narrow channel in shape of an S, descended with almost incredible rapidity, hardly obeying the oars. João and Victorino stood on the bank to catch the ropes when thrown and to pull her toward still water. Unfortunately they were not able to haul her landward, and the boat, impelled by the force of the water, dragged the two men along and dashed against the rocks at the point of the island, splitting her prow and throwing Manguary into the water. For a moment he was out of sight, but Laurindo, with great agility, was immediately on the rocks and, rope in hand, was soon helping Manguary up. Then they hauled the boat back into the channel, but the strength of the current forced the rope out of their hands, and the boat rushed down the river to a pool where the men, by swimming, caught her again.

At 4:30 we set out and before 5 o'clock we had crossed seven shoals. We were then obliged to stop and wait until the next morning in order to transport our baggage across the island. *Farinha* and a few nuts are all the food in our possession. Neither game nor fish could we find.

Fall after Fall and Shoal after Shoal

May 21. At 6 A. M. we were up and ready to start with our baggage across an island just below our encampment. Fall after fall and six more shoals still appeared in our way, and, at almost every one, we were obliged to stop as before and examine the channels. At 2:40 in the afternoon we heard very distinctly the roar of a large fall and by 3 o'clock we were unloading our baggage at a spot 50 meters above it.

I was charmed with the beautiful spectacle before me. The river leaps from a high point, falling in a single stream a distance of 8 meters. There another fall is formed, having a considerable slope and only 4 meters high. Is it possible that we shall encounter more impediments and be prevented from continuing our trip?

During the whole of today we have traveled only one hour and twenty minutes and . . . we thank God for that! At last we were fortunate enough to catch our first *piranhas* (a kind of fish). Victorino has succeeded in getting us six of them, and they are nice and large. Candido and João have given us one *cojubim* and three *barrigudo* monkeys. I wonder how we shall come out!

May 22. We have done little today. Still we have transported the small boat over the flagstones at the big fall, and tomorrow I shall explore

the river below our camp. Is it possible we shall still find great falls? It would seem incredible! We are now at the end of May and very far yet from any supplies.

After all, let us endure with patience and resignation, since this is our lot, and we shall work with pertinacity to fulfill our mission. How distressed must my family be for news from me!

Fresh Signs of Indians

May 23. After some effort we succeeded in transporting the boat, by land and by water, to our landing place by 3:30 in the afternoon. To get it over the flagstones at the big fall we had to make a kind of bridge. Tomorrow I hope to get the large one over and, God willing, we shall leave in the afternoon. This afternoon I sent Candido and Victorino in the boat to the other side of the river to hunt for nuts. An hour afterward they returned saying they had seen new signs of Indians there: a wigwam of wild banana leaves, badly made and showing that the leaves had been torn from the trees by main force; three great heaps of broken nuts; and three other old wigwams, one burnt. These Indians come from the region beyond, as the road indicates; and it is clear they are not acquainted with our implements.

Fortunate Passage of the Boat

May 24. From early in the morning we have been working to transport the large boat. By a tremendous effort we succeeded in dragging it to the bridge we made to unite the two flagstones at the fall. Just there it tumbled and landed below with the stern split. I have just left the men to cast it into the water. Very likely it will catch on some stone, and, in this case, we shall have to make another. We have done all we could to rescue it (12 o'clock). Our fare continues to be insufficient to sustain us. I am all gone with hunger. However, this is life; and I must be resigned to it.

By wonderful good luck we forced the large boat just below the great fall, and a few minutes afterward, as if guided by a human hand, it went straight to the channel of the second fall below. Taking the channel it descended and passed out of sight, to come to view again 300 meters away. There Laurindo and Manguary, jumping into the water, caught it just below our camp.

May 25. We set out at 5 A. M., and during the entire day we have not traveled ten minutes without having to stop to pass sometimes falls and sometimes shoals. Four times we transported the baggage by land and in the evening encamped on a little beach just above large shoals.

Our breakfast and our dinner consisted of a cup of *farinha.* There is not even a bird for bait. In the afternoon we passed an Indian footbridge. The Indians are near us, for we have seen signs of them recently.

Triple Falls at Last

May 26. We set out at 6 o'clock in the morning from Camp No. 41 and stopped in still waters near a lake where there are many fish. I sent Candido, Laurindo, and João to hunt and also to look for some nuts, for we have been out of these for a long time. Victorino and Bernardino went to explore the river below, for it gets much narrower and runs rapidly. Thank God, we have passed successfully the falls and the shoals. The men I sent to hunt did not bring back anything except a few nuts, and on these we made our breakfast. Just below our Camp No. 42 there are no less than three falls! It really seems a joke! I have not seen them yet, since my eruption will not permit walking; but I trust in God that we shall go on with our voyage and save the boats. What a horrible thing is this river!

We did not travel today more than ten minutes. At this rate when shall we get to the Madeira?

May 27. Camp No. 43. We are in camp below the last fall. The middle one is 2 meters high and the other two are about 1½ each. The passage of the last two is very dangerous, but I have faith in God that nothing will happen to us. The place here is like that behind us, very mountainous, but farther down it is level. The woods are better, and hills do not appear ahead. I am glad to say we had fish for breakfast, and for dinner the men ate a monkey. I only ate a little rice (from a can I had reserved for the sick) with nuts, for I was feeling very ill.

Another Disaster

May 28. We went this morning to transport the boats. The large boat on entering a channel at the first fall, owing to the current, got under way and, the men being forced to cast off the rope, ran down and stopped in still water between the second and third falls.

This smashed the prow, the bench in the middle broke, and the bottom split so as to leak slightly. The small boat, which was in still water above the second fall, also broke the rope that held it and was seen only once afterward. We lost the "*F*————" —the veteran of the Ananáz—which ..... with me the first days of the exploration in an Indian port. This occurred at 10 A. M. At 2 o'clock in the afternoon we had a fine cashew cut down to make another. Nevertheless, God is great and will not forsake us. This means four more days lost!

The diary terminates here. Recalling the hardships of one of de Souza's men who, after the Indian attack, journeyed alone for forty-six days more downstream, it seems probable that de Souza himself would have proved too ill and weak to stand the long voyage. His work must be regarded as an heroic pioneer endeavor. Until a first voyage, with all its hazards, had

outlined the main course of the stream, the nature of the country, and the character of the work itself, adequate equipment for the dangerous trip could not be provided.

Like the Madeira and the Rio Theodoro, the Ananáz cuts athwart the old mountain axes that extend into the low Amazon country from the Brazilian uplands. It is at such places that the broken relief and the falls are encountered. The fuller history of these extremely interesting topographic relics will be one of the objects of later exploration.

Both Colonel Roosevelt and Colonel Rondon were recipients of the Livingstone Centenary Gold Medal of this Society and both took occasion to speak in the warmest terms of the work and sacrifice of Lieutenant de Souza.

THE NEW BOUNDARIES OF AUSTRIA

[With separate map, Pl. VI, facing p. 348.]

The new boundaries of Austria are defined in Articles 27, 49, and 50 of the treaty of peace between the Allied and Associated Powers and Austria signed at Saint-Germain-en-Laye, September 10, 1919. The accompanying map (Pl. VI) is based on the official text.[1] The boundary as there defined was plotted on the relevant sheets of the Austrian staff map known as the "Generalkarte von Mitteleuropa, 1:200,000," and, where necessary, on the "Spezialkarte der österreichisch-ungarischen Monarchie, 1:75,000," —the two series evidently used by the peace commissioners in formulating the boundary definition—and then transferred to atlas sheets in 1:750,000, on which scale the final drawing was made, to be reduced ultimately to 1:1,500,000 in engraving. Plate VI is, therefore, more refined even than the official map accompanying the treaty text. Although this is on a larger scale, 1:1,000,000, the new boundaries are somewhat boldly drawn and, in the segments consisting of drainage divides, rather generalized. The official map need not, however, aspire to extreme accuracy inasmuch as, according to Article 28 of the treaty, "in case of differences between the text and the map, the text will prevail."

In the following reprinting of the boundary-defining passages of the treaty text, a slight change has been made in the paragraphing. In the original the clause defining the end points of a segment of the boundary to be described and the clause immediately following describing the boundary between these end points are each printed as a separate paragraph. In our reprint the two clauses, for the sake of clearness, have been combined into one paragraph throughout.

ARTICLE 27.

The frontiers of Austria shall be fixed as follows (see annexed map):

1. *With Switzerland and Lichtenstein:*[2]

The present frontier.

2. *With Italy:*

From the point 2645 (Gruben J[och]) eastwards to point 2915 (Klopaier Spitz), a line to be fixed on the ground passing through point 1483 on the Reschen-Nauders road;

Thence eastwards to the summit of Dreiherrn Spitz (point 3505), the watershed between the basins of the Inn to the north and the Adige to the south;

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[1] Traité de paix entre les puissances alliées et associées et l'Autriche, protocole et déclarations, signés à Saint-Germain-en-Laye le 10 septembre, 1919. vi+vi+vi+536+4+4+2 pp. [Paris, 1919.] 12⅝×8⅛ inches. Text in French, English, and Italian. Accompanied, in pocket, by map, 1:1,000,000, showing the new boundaries on a transfer of a section of the Royal Geographical Society's map of Europe on that scale.

As a United States government publication the treaty text has appeared, in both cases without the map, in (1) *Congressional Record*, Sept. 15, 1919, pp. 5732-5779, and (2) *66th Congress, 1st Session, Senate Document No. 92* (the latter in a limited edition only).

[2] Liechtenstein is the official spelling of the principality.

Thence generally south-southeastwards to point 2545 (Marchkinkele), the watershed between the basins of the Drave to the east and the Adige to the west;

Thence southeastwards to point 2483 (Helm Spitz), a line to be fixed on the ground crossing the Drave between Winnbach and Arnbach;

Thence east-southeastwards to point 2050 (Osternig) about 9 kilometers northwest of Tarvis, the watershed between the basins of the Drave on the north and successively the basins of the Sextenbach, the Piave, and the Tagliamento on the south;

Thence east-southeastwards to point 1492 (about 2 kilometers west of Thörl), the watershed between the Gail and the Gailitz;

Thence eastwards to point 1509 (Pec),[3] a line to be fixed on the ground cutting the Gailitz south of the town and station of Thörl and passing by point 1270 (Cabin[4] Berg).

3. *On the south, and then with the Klagenfurt area,* subject to the provisions of Section II of Part III (Political Clauses for Europe):

From point 1509 (Pec)[3] eastwards to point 1817 (Malestiger);[5] the crest of the Karavanken;

From point 1817 (Malestiger) and in a northeasterly direction as far as the Drave at a point situated about 1 kilometer southeast of the railway bridge on the eastern branch of the bend made by that river about 6 kilometers east of Villach, a line to be fixed on the ground cutting the railway between Mallestig and Faak and passing through point 666 (Polana);

Thence in a southeasterly direction to a point about 2 kilometers above St. Martin, the course of the Drave;

Thence in a northerly direction as far as point 871, about 10 kilometers to the east-northeast of Villach, a line running approximately from south to north to be fixed on the ground;

Thence east-northeastwards to a point to be chosen near point 725 about 10 kilometers northwest of Klagenfurt on the administrative boundary between the districts of St. Veit and Klagenfurt, a line to be fixed on the ground passing through points 1069 (Taubenbühel), 1045 (Gallinberg), and 815 (Freudenberg);

Thence eastwards to a point to be chosen on the ground west of point 1075 (Steinbruch Kogel), the administrative boundary between the districts of St. Veit and Klagenfurt;

Thence northeastwards to the point on the Gurk where the administrative boundary of the district of Völkermarkt leaves that river, a line to be fixed on the ground passing through point 1076;

Thence northeastwards to point 1899 (Speikkogl), the administrative boundary between the districts of St. Veit and Völkermarkt;

Thence southeastwards to point 842 (1 kilometer west of Kasparstein), the northeastern boundary of the district of Völkermarkt;

Thence eastwards to point 1522 (Hühner Kogel), a line to be fixed on the ground passing north of Lavamünd.

4. *With the Serb-Croat-Slovene State,* subject to the provisions of Section II of Part III (Political Clauses for Europe):

From point 1522 (Hühner Kogel) eastwards to point 917 (St. Lorenzen), a line to be fixed on the ground passing through point 1330;

Thence eastwards to the point where it meets the administrative boundary between the districts of Marburg and Leibnitz, the watershed between the basins of the Drave to the south and the Saggau to the north;

Thence northeastwards to the point where this administrative boundary meets the Mur, the above-mentioned administrative boundary;

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[3] Peč on the 1:200,000 map.

[4] Čabin on the 1:75,000 map.

[5] 1801 (Mallestiger) on 1:75,000 map; 1817 (Malestiger Mittagskogl) on 1:200,000 map.

Thence to the point where it meets the old frontiers of 1867 between Austria and Hungary about 5 kilometers southeast of Radkersburg, the principal course of the Mur downstream;

Thence northwards to a point to be fixed east of point 400 about 16 kilometers north of Radkersburg, the old frontier of 1867 between Austria and Hungary;

Thence northeastwards to a point to be fixed on the watershed between the basins of the Raab and the Mur about 2 kilometers east of Toka,[6] being the point common to the three frontiers of Austria, Hungary, and the Serb-Croat-Slovene State, a line to be fixed on the ground, passing between the villages of Bonisfalva[7] and Gedoudvar.[8]

5. *With Hungary:*

From the point above defined northeastwards to point 353 about 6 kilometers north-northeast of Szentgotthard, a line to be fixed on the ground passing through point 353 (Janke B.), then west of the Radkersburg-Szentgotthard road and east of the villages of Nagyfalva, Nemetlak,[9] and Rabakeresztur;[10]

Thence in a general northeasterly direction to point 234 about 7 kilometers north-northeast of Pinkamindszent, a line to be fixed on the ground passing through point 323 (Hochkogel), then south of the villages of Zsamand,[11] Nemetbükkös,[12] and Karacsfa,[13] and between Nagysaroslak[14] and Pinkamindszent;

Thence northwards to point 883 (Trött Kö)[15] about 9 kilometers southwest of Köszeg, a line to be fixed on the ground passing through points 241, 260, and 273, then east of Nagynarda and Rohoncz and west of Dozmat and Butsching;

Thence northeastwards to point 265 (Kamenje) about 2 kilometers southeast of Nikitsch, a line to be fixed on the ground, passing southeast of Liebing, Olmod,[16] and Locsmand,[17] and northwest of Köszeg and the road from Köszeg to Salamonfa;

Thence northwards to a point to be selected on the southern shore of Neusiedler See between Holling and Hidegseg,[18] a line to be fixed on the ground, passing east of Nikitsch and Zinkendorf and west of Kövesd and Nemet-Pereszteg;[19]

Thence eastwards to point 115 situated about 8 kilometers southwest of St. Johann, a line to be fixed on the ground, crossing the Neusiedler See, passing south of the island containing point 117, leaving in Hungary the branch railway running northwestwards from the station of Mexiko[20] as well as the entire Einser canal, and passing south of Pamhagen;

Thence northwards to a point to be selected about 1 kilometer west of Antonienhof (east of Kittsee), being the point common to the three frontiers of Austria, Hungary, and the Czecho-Slovak State, a line to be fixed on the ground, leaving entirely in Hungarian territory the Csorna-Karlburg railway and passing west of Wüst-Sommerein and Kr. Jahrndorf, and east of Andau, Nikelsdorf,[21] D. Jahrndorf, and Kittsee.

6. *With the Czecho-Slovak State:*

From the point above defined northwestwards to the bend of the old frontier of 1867 between Austria and Hungary about 2½ kilometers northeast of Berg, a line to be fixed on the ground, cutting the Kittsee-Pressburg road about 2 kilometers north of Kittsee;

Thence northwards to a point to be selected on the principal channel of navigation of the Danube about 4½ kilometers upstream from the Pressburg bridge, a line to be fixed on the ground following as much as possible the old frontier of 1867 between Austria and Hungary;

Thence westwards to the confluence of the Morava (March) with the Danube, the principal channel of navigation of the Danube;

Thence the course of the Morava upstream, then the course of the Thaya upstream

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[6] Tóka on the 1:200,000 map. [7] Bónisfalva. [8] Gedöudvar. [9] Németlak. [10] Rábakeresztúr. [11] Zsámand. [12] Németbükkös. [13] Karácsfa. [14] Nagysároslak. [15] Trott-kö. [16] Ólmod. [17] Locsmánd. [18] Hidegség. [19] Német-Pereszteg. [20] This locality should be spelled thus on Pl. VI, and not Mexico. [21] Nickelsdorf.

to a point to be selected about 2 kilometers southeast of the intersection of the Rabensburg-Themenau road with the Rabensburg-Lundenburg railway;

Thence west-northwestwards to a point on the old administrative boundary between Lower Austria and Moravia situated about 400 meters south of the point where this boundary cuts the Nikolsburg-Feldsberg railway, a line to be fixed on the ground passing through points 187 (Dlouhyvrch),[22] 221 (Rosenbergen), 223 (Wolfsberg), 291 (Raistenberg), 249, and 279 (Kallerhaide);

Thence west-northwestwards the above-mentioned administrative boundary;

Thence westwards to a point to be selected about 3 kilometers east of the village of Franzensthal, the old administrative boundary between Lower Austria and Bohemia;

Thence southwards to point 498 (Gelsenberg) about 5 kilometers north-northwest of Gmünd, a line to be fixed on the ground passing east of the Rottenschachen-Zuggers road and through points 537 and 522 (G. Nagel B.);

Thence southwards and then west-northwestwards to a point on the old administrative boundary between Lower Austria and Bohemia situated about 200 meters north of the point where it cuts the Gratzen-Weitra road, a line to be fixed on the ground passing between Zuggers and Breitensee, then through the most southeasterly point of the railway bridge over the Lainsitz leaving to Austria the town of Gmünd and to the Czecho-Slovak State the station and railway works of Gmünd (Wolfshof) and the junction of the Gmünd-Budweis and Gmünd-Wittingau railways, then passing through points 524 (Grundbühel), 577 (north of Hohenberg),[23] and 681 (Lagerberg);

Thence southwestwards the above-mentioned administrative boundary;

Then northwestwards the old administrative boundary between Upper Austria and Bohemia to its point of junction with the frontier of Germany.

7. *With Germany:*

The frontier of August 3, 1914.

ARTICLE 49.

The inhabitants of the Klagenfurt area will be called upon to the extent stated below, to indicate by a vote the state to which they wish the territory to belong.

The boundaries of the Klagenfurt area are as follows:

From point 871, about 10 kilometers to the east-northeast of Villach, southwards to a point on the Drave about 2 kilometers above St. Martin, a line running approximately from north to south to be fixed on the ground;

Thence in a northwesterly direction as far as a point about 1 kilometer southeast of the railway bridge on the eastern branch of the bend formed by the Drave about 6 kilometers to the east of Villach, the course of the Drave;

Thence in a southwesterly direction to point 1817 (Malestiger), a line to be fixed on the ground passing through point 666 (Polana) and cutting the railway between Mallestig and Faak;

Thence in an east-southeasterly direction, then northeast to point 1929 (Gushowa),[24] the watershed between the basins of the Drave to the north and the Save to the south;

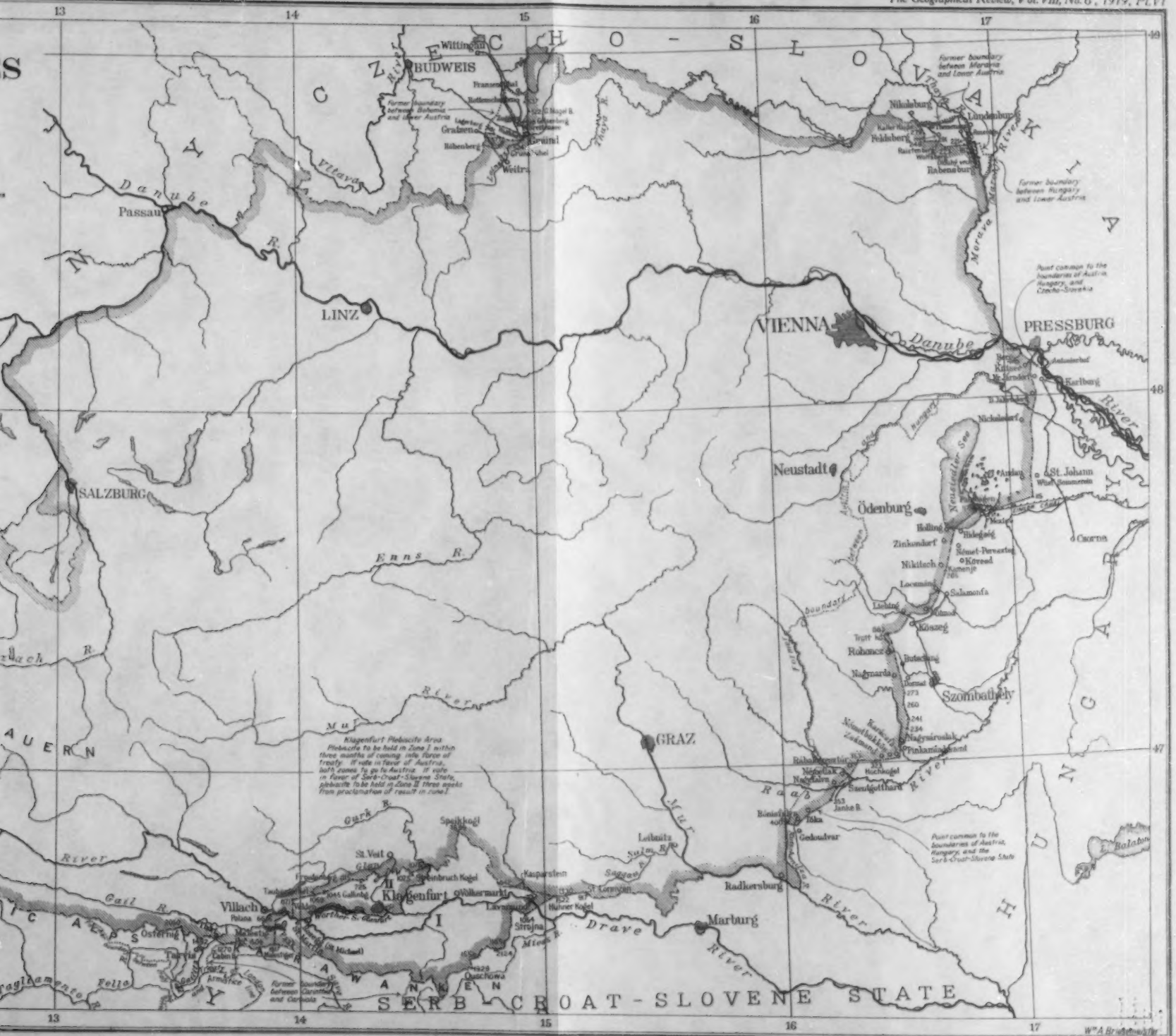
Thence northeast to point 1054 (Strojna), a line to be fixed on the ground following in a general manner the western boundary of the basin of the Miess, passing through points 1558, 2124, and 1185;

Thence northeast to point 1522 (Hühner Kogel), a line to be fixed on the ground, crossing the Drave to the south of Lavamünd;

Thence westwards to point 842, 1 kilometer west of Kasparstein, a line to be fixed on the ground passing to the north of Lavamünd;

[22] Dlouhý vrch on the 1:200,000 map. [23] Höhenberg. [24] Ouschowa on the 1:75,000 and 1:200,000 maps.

MAP SHOWING
THE NEW BOUNDARIES
OF
AUSTRIA
Based on Arts. 27 and 49 of the Treaty of St. Germain-en-Laye, signed Sept. 10, 1919
Scale 1:1500 000
40 kilometers
40 miles
International boundaries
New boundaries of Austria
Superseded boundaries of 1914, both international and interprovincial
Triangulated points
1482 Elevations in meters
All the geographical features mentioned in the treaty text to define the boundary are shown on the map
RELATION
OF THE NEW
REPUBLIC OF AUSTRIA
TO THE FORMER
AUSTRO-HUNGARIAN MONARCHY
Scale 1:15000000
BOHEMIA
MORAVIA
GALICIA
HUNGARY
BUKOVINA
CROATIA-SLAVONIA
BOSNIA
SERBIA
MUNICH
INNSBRUCK
Inn River
Salzach
Brenner Pass
Dreiherrn Spitz
3506
ALPS
Sterzing
Nauders
Reschen
ÖTZTAL
Glurns
Adige
Meran
Bozen
Brixen
Eisack
Rienz
Drave
Marchkinkele
Arnbach
Tilliach
Austria
CARNIC
Rhine R.
Lake of Constance
Piave
Tagliam


13
14
15
16
17
49
48
47
C H O - S L O V A K I A
Former boundary between Moravia and Lower Austria
Former boundary between Bohemia and Lower Austria
Former boundary between Hungary and Lower Austria
Point common to the boundaries of Austria, Hungary, and Czecho-Slovakia
Point common to the boundaries of Austria, Hungary, and the Serb-Croat-Slovene State
Klagenfurt Plebiscite Area
Plebiscite to be held in Zone I within three months of coming into force of treaty. If vote in favor of Austria, both zones to go to Austria. If vote in favor of Serb-Croat-Slovene State, plebiscite to be held in Zone II three weeks from proclamation of result in zone I
Budweis
Wittingau
Gratzen
Gmünd
Weitra
Passau
Linz
Salzburg
Vienna
Pressburg
Danube River
Neustadt
Ödenburg
Sopron
Szombathely
Graz
Klagenfurt
Villach
Völkermarkt
Radkersburg
Marburg
Drave River
Mur River
Enns R.
Gail R.
Gurk R.
Raab River
Leitha R.
Neusiedler See
Lake Balaton
Austria
Hungary
SERB CROAT-SLOVENE STATE

Thence as far as point 1899 (Speikkogl), the northeastern administrative boundary of the district of Völkermarkt;

Thence in a southwesterly direction and as far as the river Gurk, the northwestern administrative boundary of the district of Völkermarkt;

Thence in a southwesterly direction as far as a point on the administrative boundary to the west of point 1075 (Steinbruch Kogel), a line to be fixed on the ground, passing through point 1076;

Thence in a westerly direction and as far [as] a point to be fixed near point 725, about 10 kilometers northwest of Klagenfurt, the administrative boundary between the districts of St. Veit and Klagenfurt;

Thence as far as point 871, which was the starting point of this description, a line to be fixed on the ground, passing through points 815 (Freudenberg), 1045 (Gallinberg), and 1069 (Taubenbühel).

ARTICLE 50.

With a view to the organization of a plebiscite, the Klagenfurt area will be divided into two zones, the first to the south and the second to the north of a transversal line of which the following is a description:

From the point where the western boundary of the area leaves the Drave in a northerly direction as far as the point about 1 kilometer to the east of Rosegg (Saint-Michael), the course of the Drave downstream;

Thence in a northeasterly direction and as far as the western extremity of the Wörther See, south of Velden, a line to be fixed on the ground;

Thence in an easterly direction to the outlet of the Glanfurt from the lake, the median line of that lake;

Thence eastwards to its confluence with the river Glan, the course of the Glanfurt downstream;

Thence eastward to its confluence with the river Gurk, the course of the Glan downstream;

Thence in a northeasterly direction, to the point where the northern boundary of the Klagenfurt area crosses the river Gurk, the course of the Gurk.

The remainder of Article 50 provides, among other things, that a plebiscite is to be held in the first zone within three months of the coming into force of the treaty. If the vote is in favor of Austria, both zones go to Austria. If the vote is in favor of the Serb-Croat-Slovene State, a plebiscite is to be held in the second zone three weeks from the proclamation of the result in the first zone.

SIZE AND POPULATION

Within its new boundaries Austria comprises: including the first plebiscite zone, 30,705 square miles; including both zones, 31,734 square miles; with an approximate population of 6,500,000. These figures for area were obtained by plotting the new boundaries on the scale of 1:1,000,000 on millimeter cross-section paper and determining the number of square millimeters enclosed, with the necessary transformations. For a geographical appraisal of the new state, comparable to South Carolina in size, see the first article in the *Journal of Geography* for January, 1920. The object of this note is merely to present an accurate delineation of the new boundaries, based on the original sources.

THE SUN'S ATMOSPHERE:
A REVIEW OF BIGELOW'S WORK ON THE SUN

By ELLSWORTH HUNTINGTON

Professor Frank H. Bigelow, lately of the U. S. Weather Bureau and now of the Argentine Meteorological Office, has recently published "A Treatise on the Sun's Radiation"[1] which is a continuation of his "A Meteorological Treatise on the Circulation and Radiation in the Atmospheres of the Earth and of the Sun,"[2] published in 1915. Both books are alike in being full of the stiffest kind of mathematics and hence in being not only incomprehensible but unreadable by the average scientist. Both are also alike, however, in being of high importance as pioneer volumes in the complete reconstruction of meteorology and solar physics which is fast acquiring momentum. The reviewer makes no pretense of being able to judge the mathematical merits of Bigelow's last book, or even of having understood a large part of it, for such an understanding is possible only to a few highly trained mathematicians. Nevertheless, he feels safe in making two statements. The first is that future work will reveal many errors. Where so many assumptions are required and so many diverse methods of calculation are available, it is humanly impossible for a pioneer worker to be entirely correct. Critics of far less ability and originality than Professor Bigelow are sure to magnify these errors, overlooking the truth which the reviewer believes to be embodied in his second statement, which follows.

IMPORTANCE OF BIGELOW'S WORK

The second statement is that Professor Bigelow's main conclusions are probably for the most part correct, and even where they are in error they take high scientific rank because of their originality and because of their stimulus to other workers. There are two main reasons why the reviewer, in spite of his inability to follow the intricate mathematical processes, believes that this statement is warranted. The first is that the author has "made good." Twenty or thirty years ago he advanced a number of new ideas which were received in some quarters almost with derision. They dealt with such matters as the shifting of storm tracks in response to solar changes, the relation of storms to magnetic disturbances, and the general relation of atmospheric circulation to solar variations. These ideas made many people regard Bigelow as "visionary," but time has vindicated him. All his main ideas, with such modifications as new work, of course, must bring, are now accepted by a large and growing body of the leading

[1] F. H. Bigelow: A Treatise on the Sun's Radiation and Other Solar Phenomena, in Continuation of the Meteorological Treatise on Atmospheric Circulation and Radiation, 1915. ix and 385 pp.; diagrs., index. John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 1918. $5.00. 9 x 6.

[2] Reviewed in the *Geogr. Rev.*, Vol. 2, 1916, pp. 323-324.

students of meteorology. In line with this progress the U. S. Weather Bureau is now experimenting with the use of solar observations in order to help in predicting the weather. The Bureau will probably have only indifferent success until the importance of electrical as well as thermal conditions is recognized, but the fact that the importance of solar variations is thus admitted is a tribute both to Bigelow and to the progressiveness of the Weather Bureau.

The second reason for thinking that Bigelow is on the right track is that the results give unity and scientific coherence to a subject which has hitherto been extremely vague. Moreover, by means of his methods, observations which had previously seemed discrepant now fall into harmony.

The Constitution of the Sun: The Isothermal Layer of Its Atmosphere

The book under review treats the sun's atmosphere exactly as the earth's atmosphere is treated in a previous book. We must think of the sun, the author tells us, as a central mass of semi-solid gases under inconceivably great pressure and at temperatures which can only be guessed. From this central mass outward there is a gradual decline in pressure and temperature according to the well-known laws of adiabatic cooling, which have been thoroughly worked out in the earth's atmosphere. Finally, on the sun, just as on the earth, an isothermal layer is reached where for an appreciable radial distance there is no change of temperature. In this layer several important alterations take place. First, many or perhaps all of the elements are transformed from the atomic to the molecular condition. The heat given out by this transformation is apparently the reason why the solar atmosphere does not change in temperature. Again, the heavier gases, such as those of the metallic elements, here reach their highest level. An occasional jet of iron or mercury or some other heavy element may be carried up in a vortical whirl, but only rarely and to a short distance, for its weight causes it to fall back at once. The presence of the isothermal layer and the fact that the heavy elements rise no higher explain a condition which has puzzled a great many students, namely the sharpness of the sun's rim. According to the old ideas the gaseous condition of the sun ought to give a hazy rim corresponding to a gradual decrease in the density of the gases. Bigelow's hypothesis gives an edge which would appear sharp from the earth. Outside of the isothermal layer the sun's atmosphere cools more rapidly than below, for the process becomes non-adiabatic.

Bearing of Extreme Complexity of Solar Phenomena on Our Knowledge of the Relationship Between the Sun and the Earth

The conception of an isothermal layer leads to an explanation of sun spots, faculae, floceuli, and prominences. Each is due to some special

method by which the gases below the isothermal layer break through and are shot outward and then grow cool and fall back. For the ordinary worker the great lesson of this part of the book is the extreme complexity of the solar phenomena and the probability that a vast number of changes occur in such a way that they cannot be detected from the earth except by the use of new methods. The most hopeful method for such detection lies in further study of electrical, magnetic, and perhaps radioactive conditions, but even these may not reveal all the sun's activities. Hence if a connection between sun spots and weather is established, as has been done again and again, the chances are that the real connection is far greater than appears on the face of the returns, for an unknown number of other unmeasured solar conditions are also changing. The true relationship between the sun and the earth can be determined only by combining all of these solar phenomena on the one hand and all the changes in the earth's atmosphere on the other.

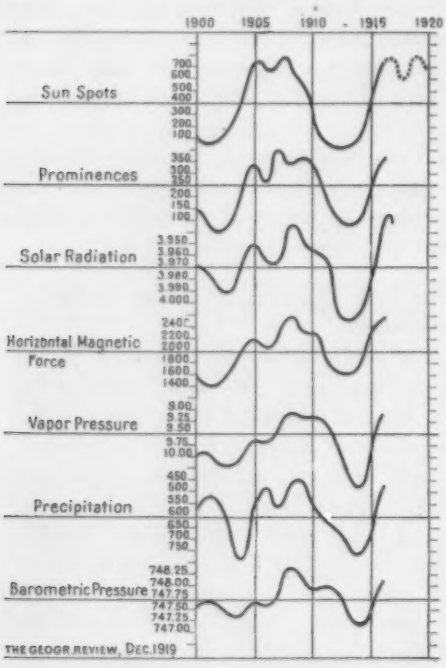


FIG. 1—Diagram showing the synchronism of the solar and terrestrial variations (reproduced from Fig. 27 of F. H. Bigelow's "A Treatise on the Sun's Radiation," 1918).

NEED OF CO-ORDINATION OF SOLAR AND TERRESTRIAL DATA

In this connection Bigelow points out[3] that the "growth of research is unduly retarded" because the solar and terrestrial data are

not sufficiently homogeneous to bring out clearly the small true solar residuals; the observations are made in the interests of short-range forecasts to the entire neglect of the long-range forecasts of solar physics; the several branches of the subject are so scattered as to be unmanageable—the solar physics, the bolometric spectra, the magnetic field, the electric ionization, the climatic meteorology, all being separated among different administrative offices; the published reports from these different sources are so retarded that they are useless in any study of current forecasts whatsoever; there exists no systematic machinery for handling this kind of world-wide material.

It is inevitable that several international institutes shall be established—*at least four*, one in the United States, one in Argentina, one in Europe or Asia, and one in Africa or

[3] P. 237.

Australia—which shall co-operate upon a fixed general plan, utilize selected data, and treat the subject from the world-wide point of view. The long-range system [of forecasting which Bigelow believes to be now practicable] will begin with annual forecasts, already easy in Argentina, and advance to details [as to months, weeks, and days] in accordance with the progress in solar physics.

Whatever his views may be, no student of meteorology, climatology, magnetism, or solar physics, will question the value of such institutes. From the purely financial standpoint they would in a few decades prove great money-makers, not for themselves, but for mankind.

Agreement Between Solar and Terrestrial Phenomena

Turning now to the point which gives chief interest to all solar studies, namely their relation to the earth, Bigelow does not take this up so fully as might be wished. In fact the greatest lack of the book is actual facts as opposed to theoretical deductions. On page 234, however, the author gives a set of tables which are so valuable that they are here reproduced, together with the corresponding diagram. A marked agreement between solar and terrestrial phenomena is evident both in the 11-year cycle and in a shorter cycle which Bigelow calls 3.75 years.

Summary of the Solar and Terrestrial Observations Showing a Synchronism in the Variations in the 11-Year and the 3.75-Year Periods

Year of Observation	Sun Spots	Prominences	Radiations	Horizontal Magnetic Amplitudes	Precipitation	Temperature	Vapor Pressure	Barometric Pressure
1900	114	128	.....	1,589	855	17.81	10.50	749.28
1901	33	88	.....	1,374	573	17.87	9.88	49.43
1902	60	47	.....	1,464	716	17.68	10.35	48.59
1903	293	118	3.989	1,926	775	17.49	10.52	49.22
1904	503	291	3.979	1,787	914	17.17	10.30	49.12
1905	762	302	3.955	2,194	719	16.75	10.22	49.24
1906	646	261	3.975	2,015	613	17.55	10.07	49.33
1907	745	427	3.971	2,299	648	16.83	9.86	49.52
1908	583	346	3.940	2,584	615	17.11	9.55	49.97
1909	527	365	3.960	2,334	566	17.08	9.34	49.90
1910	223	259	3.952	2,354	651	16.96	9.31	49.59
1911	68	163	3.960	1,923	751	16.40	9.26	49.75
1912	43	126	3.978	1,520	811	17.51	10.09	49.72
1913	17	135	4.003	1,564	704	18.19	10.53	49.44
1914	115	198	4.002	1,672	928	17.28	10.78	48.77
1915	350	250	3.990	2,635	773	17.32	10.06	48.92
1916	540	400	3.920	2,676	486	17.65	8.87	49.00

Sun spots.—Data from Wolfer's frequency numbers, *Meteorol. Zeitschr.*, May, 1902; May, 1915.

Prominences.—Data from Ricco's Distribuzione delle protuberanze, *Memorie Soc. degli Spettroscopisti Italiani*, March, 1914.

Radiation.—Bigelow's reduction of the pyrheliometer data.

Horizontal Magnetic Amplitudes.—Bigelow's compilation from European observatories and Pilar, Argentina.

Precipitation, Temperature, Vapor Pressure, and Barometric Pressure.—From the Argentine stations Tucumán, Andalgala, Goya, Concordia, Córdoba, Pilar, Buenos Aires, Victorica, Bahia Blanca, Patagones.

Value of the Solar Constant

One other point deserves notice. Bigelow disagrees radically with Abbot as to the value of the solar constant. He holds that in his calcula-

tions Abbot has omitted important factors, such as potential and electromagnetic energy, which ought to be considered as well as kinetic energy. The question is so purely mathematical that the reviewer cannot judge its merits; but Bigelow's results seem to be the more consistent. He concludes that the temperature at the sun's isothermal layer is 7,655°C. This gives a solar constant of 5.85 gram calories per centimeter per minute, but in passing through the rest of the sun's atmosphere this is diminished to 3.98. Bigelow seems to state that the difference in brightness between the sun's center and edge is equal to the diminution which the sun's energy suffers in passing out from the sun into space, that is $5.85-3.98=1.87$; but it is impossible to tell how he arrives at this conclusion. The value 3.98 is held to be the amount of energy received at the upper limit of the earth's atmosphere, a value which Abbot puts at only 1.93, or half as much. The difference between these two views is of great practical importance because the greater the energy received from the sun, the greater the intensity of changes, and the greater the likelihood that the breaking forth of the hot lower solar gases through the isothermal layer may cause pronounced climatic fluctuations upon the earth.

GEOGRAPHICAL RECORD

AMERICAN GEOGRAPHICAL SOCIETY

Distribution of Title Page, Contents, and Index of Volume VIII of the "Geographical Review." The title page, table of contents, and index for the current volume of the *Geographical Review* (Vol. VIII, July-December, 1919) will be issued separately and not with the present number. Copies will be sent to all institutions exchanging publications with the Society and, on request, to others who desire to receive them.

NORTH AMERICA

The Alleged Journey of James White Through the Grand Canyon in 1867. Mr. Robert Brewster Stanton, of New Canaan, Conn., made a railroad survey through the canyons of the Colorado in 1889 and 1890, when he followed the main river from Green River Station, Wyo., to the Gulf of California; he later spent several years on the river and knows its turbulent waters intimately. He has lately prepared a valuable discussion of "The Alleged Journey and the Real Journey of James White on the Colorado River in 1867," which appeared in the September, 1919, number of *The Trail*, a monthly publication issued at Denver as the official organ of the Sons of Colorado and other local societies. In spite of the pamphlet by Thomas F. Dawson printed by the United States Senate in 1917 (The Grand Canyon: An Article Giving the Credit of First Traversing the Grand Canyon of the Colorado to James White. . . . , *65th Congr., 1st Sess., Senate Doc. No. 42*, 67 pp., Washington, D. C., 1917), in which it is maintained that White actually descended the river on a raft for 550 miles, including the Grand Canyon stretch, and in spite of a further statement by Dawson to similar effect in *The Trail* for February, 1919, Stanton not only shows that these statements are erroneous but explains in the clearest manner how the published errors entered the story. He tells of a personal interview with White in 1907 and of his estimate of him as a perfectly honest and truthful but uneducated man; of the way in which White was led, by a remark made to him by Dr. C. C. Parry (see below), whom he met at Callville, where his raft journey ended, to believe that he had descended the river for 550 miles and therefore, as Dr. Parry told him, from above the junction of the Green and the Grand; of White's own perfectly definite and consistent statements regarding the height and color of the canyon walls and regarding the side of the canyon from which tributary rivers enter it; and of the clear evidence afforded by these statements that the river which White had called the Little Colorado on the authority of Dr. Parry and which enters the Colorado from the left (south), upstream from the Grand Canyon, was really the Virgin, which enters the Colorado from the right (north), as White himself testified emphatically, and below the Grand Canyon. It was therefore in the neighborhood of the Virgin River confluence, west of the Grand Wash Cliffs and below the Grand Canyon, that White's raft journey began; and the canyons through which he passed between there and Callville, where he left the river, are those by which certain Basin Ranges are traversed.

To those who are interested in tracing the development of the claim that James White in 1867—and not Major Powell in his famous trip of 1869—was the first navigator of the Grand Canyon stretch of the Colorado River, the following statements may be helpful. The first account of White's journey is contained in a report by Dr. C. C. Parry, assistant geologist of the Union Pacific Railway (also known as the Kansas Pacific Railway) survey of 1867-68, dated January 6, 1868, which was read on February 17, 1868, before the Academy of Science of St. Louis and published in its *Transactions*, Vol. 2, 1861-68, pp. 499-503, in advance of its publication in the official report made to the company by General William J. Palmer, Director of Surveys, entitled "Report of Surveys Across the Continent," 1868. (Dr. Parry had served as botanist and geologist on the Mexican Boundary Surveys of 1849 and 1854-55.) Possibly the best known version of White's journey is that which constitutes Chapter 13 of Part III of "New Tracks in North America" (2 vols., London, 1869) by William A. Bell. This account was prepared from Dr. Parry's notes by Major A. R. Calhoun, who accompanied the Kansas Pacific survey expedition as correspondent of the *Philadelphia Press*. Dr. Bell was physician to the expedition. Major Calhoun's account was, it seems, also published in Philadelphia at about the same time in a small book entitled "Wonderful Adventures." A newspaper version of White's journey appeared in the *Rocky Mountain*

Herald for January 8, 1869, and the *Rocky Mountain News* for February 17, 18, and 19, 1869. Except for the photographic reproduction in *Outing Magazine* for April, 1907 (pp. 48-49), of a letter about his journey that White wrote on September 26, 1867, to a brother then living in Wisconsin, these seem to have been the main sources of information until *Senate Document No. 42* appeared. This contains (pp. 39-43) an account by White himself written in 1916, in his seventy-ninth year. The leading criticism of White's story prior to the present discussion of the question appears in F. S. Dellenbaugh's "The Romance of the Colorado River" (New York, 1906, pp. 174-183). In his second book on the Colorado, "A Canyon Voyage" (New York, 1908, pp. v and 2), Mr. Dellenbaugh, who was a member of Powell's second (1871-72) expedition, briefly repeats his doubt as to White's trip, a doubt which had likewise been expressed by Mr. Stanton in 1892 in his "Availability of the Cañons of the Colorado River of the West for Railway Purposes" (*Trans. Amer. Soc. of Civil Engineers*, Vol. 26, 1892, pp. 283-362) and by George Wharton James in his "In and Around the Grand Canyon" (Boston, 1900, pp. 17-18).

Mr. Stanton's article in the September, 1919, number of *The Trail* is an abstract from a manuscript which treats in much detail "The Exploration, Navigation, and Survey of the Colorado River of the West" from 1540 to the present time. It is to be hoped that this manuscript may be published as a valuable contribution to American history.

Among later boat journeys down the Colorado mention may be made of one conducted by Julius F. Stone, of Columbus, Ohio, who started from Green River Station, Wyo., on September 12, 1909, with four companions, one of whom was compelled for business reasons to withdraw near the head of Glen Canyon. The others completed the trip through the Grand Canyon and arrived at Needles, Cal., on November 19. Mr. Stone was exceptionally successful in photographing the canyon; his albums contain an unrivaled series of views. As far as is known, no account of this journey has hitherto been published.

W. M. DAVIS

SOUTH AMERICA

Geography and the Colombian Coffee Market. How geographical factors often influence present-day trade in staple commodities was excellently illustrated by a recent situation in the coffee market in Colombia. It will be remembered that coffee is the most valuable export product of that South American republic, forming about 50 per cent of the trade to foreign countries.

During June, 1919, very unusual quotations prevailed in the market there. The prices offered for immediate delivery rose to unheard-of points, while at the same time the prices for future delivery remained quite normal, even though speculators attempted to bring about a corresponding rise and rumors of an impending shortage were circulated in North American markets. The reason for the peculiar situation was attributed to the very small quantity of "spot" coffee offered for sale. This in turn resulted from a serious lack of rainfall during the preceding months of April and May, when the highlands and the upper valleys of the Colombian Andes usually receive a great proportion of their yearly precipitation. It was not, however, because of a crop failure that prices soared, else "futures" too would have shared in the fluctuation. The explanation lay rather in the effect of a light rainfall upon the volume of water carried by the streams upon which transportation depended.

The mountainous character of Colombia has hindered railway development and so compelled it to depend largely upon river navigation for the movement of its products. The streams, in their upper courses mere mountain torrents, are navigable, in many cases, only after heavy rains on the uplands whence they spring. Even traffic on the great Magdalena ("Colombia's life line," as it has been called) is subject to serious interruptions in seasons of light rain, at times a whole month elapsing without the passing of a single steamer (see Hamilton W. Wright: Transportation on the Magdalena River, Colombia, *Scientific American Suppl.*, Feb. 8, 1919, pp. 88-89).

Most of the coffee plantations are located upon the mountain slopes that flank the Magdalena and its tributaries, the Cauca, the Lebriga, and the Sogamoso. The lack of water in these streams during the past summer, when precipitation had been scanty, so reduced their volume that much of the season's coffee crop, harvested in March and April, was held at interior points until the rivers rose sufficiently to float it, thus producing a crisis in the market for "spot" coffee, though the trade in "futures" remained unaffected.

The Climate of São Paulo and Ceará, Brazil. Mr. R. C. Mossman, who was for some years connected with the Argentine Meteorological Service, is at present devoting

attention to the climatology of various portions of South America. Hitherto by far the greater part of all available published data for South America have covered varying periods of time and have not been reduced to a homogeneous system. Hence these observations have not been directly comparable and have lacked the accuracy which is an absolute essential in all good climatological work. In two recent communications (*Quart. Journ. Royal Meteorol. Soc.*, Jan., 1919), Mr. Mossman gives the results of compilations which he has completed for the state of São Paulo and for the city of Fortaleza in the state of Ceará, Brazil. The chief interest of São Paulo centers in its coffee industry, but the region is also becoming more and more a cattle country. Mr. Mossman has now reduced the temperatures and rainfalls of São Paulo, as published, to a homogeneous system. The data were extracted from the "Dados Climatologicos" of the Serviço Meteorologico de São Paulo, issued since 1887, the last volume published dealing with the year ending November, 1912. These bulletins give an abundance of climatic information with a detail "such as is available for no other portion of South America." Mr. Mossman's summary includes all the essential facts.

The special interest of the state of Ceará lies in the fact that this region is periodically visited by severe droughts, and the object of the present study is to summarize the results regarding rainfall obtained from 1849 to 1915, the ultimate end in view being an investigation which it is hoped may lead to a clue concerning the "precise mechanism associated with these droughts." The rainfall data are given in great detail, in convenient and easily accessible form, and will prove of distinct value to all those who are interested in the economic climatology of Brazil.

R. DEC. WARD

EUROPE

Peace Treaty Texts and Maps. Since the publication of the article on the new boundaries of Germany in the May number, the *Geographical Review* has presented no further information on the territorial changes resulting from the settlements of the war. The reason for this is that for none of the countries affected is the complete circuit of its boundaries defined. For some all parts of their new boundaries are accounted for, some parts being fixed, while others are dependent on the result of plebiscites still to be held; of other countries large parts of their boundaries are not even defined. Austria is for the moment the country most completely outlined; its boundaries will be complete when the relatively small part involved in the Klagenfurt area shall be decided by plebiscite. The boundaries of this country therefore lending themselves to precise definition and representation, they are given in the present number of the *Review* (pp. 345-349, with Pl. V). As soon as feasible, the boundaries of the other countries affected will likewise be represented in the *Review;* in the meantime this note is to serve to bring the record up to date.

The description and map of the new boundaries of Germany in the May number were based on a summary of the preliminary "conditions of peace" presented to the Germans on May 7, 1919. Before the treaty in its final form was signed on June 28 several substantial modifications had been made in the territorial clauses. According to Article 109 the southernmost of the three Slesvig plebiscite zones shown in the upper left inset of the map in the May *Review* was dropped, i. e. this zone is to remain German territory and plebiscites are to be held to determine the sovereignty of the two other zones only, in the northern as a unit within 31 days, in the southern by communes within 66 days of the coming into force of the treaty (i. e. January 10, 1920). The new eastern boundary of Germany was extensively altered in detail in the final treaty (Article 27, Section 7), but the main change was the concession to the Germans that the sovereignty of Upper Silesia be decided by plebiscite (not sooner than six months nor later than eighteen months after the establishment of an international commission in the area, to take place within fifteen days of the coming into force of the treaty; Sections 4 and 1 of Annex to Article 88).

The original source for the definition of the new boundaries is, of course, the official treaty text. In view of the relative inaccessibility of official copies, a few words of bibliographical characterization may not be amiss. The official treaty text is a paper-bound volume of xv+428+4 pages, 13 by 9 inches in size, with text in French and English on opposite pages, entitled "Treaty of Peace Between the Allied and Associated Powers and Germany and Protocol Signed at Versailles, June 28, 1919." It is accompanied by four maps, one a general map of Germany showing the new boundaries, 1:1,000,000, and three detailed maps showing respectively the Territory of the Saar, 1:100,000, the Danzig area, 1:100,000, and the Slesvig plebiscite areas, 1:200,000. The map of Germany is a transfer from the well-known map of Europe prepared by the Royal Geographical Society under the direction of the Geographical Section of the General Staff.

The new boundaries are overprinted in red, distinction being made between the sections which do and which do not require to be delineated on the ground; in addition all the towns and other geographical features referred to in the text are shown in red. The map bears the imprint of the Service Géographique de l'Armée and is dated June 23, 1919. The three detailed maps show the respective boundaries in color overprinted on a photolithographic reproduction in gray of the relevant sheets of the standard topographic map of Germany in 1:100,000. The American edition of the treaty is entitled "Treaty of Peace with Germany" (194 pp.; Washington, D. C., 1919) and forms *66th Congr., 1st Sess., Senate Doc. No. 49;* it lacks the maps. The British edition is issued as a blue book designated *Treaty Series No. 4 (1919)* and contains the maps.

As to the other treaties disposed of since then, the following may be said:

The second treaty to be concluded was that with Austria, signed at Saint-Germain-en-Laye, September 10, 1919. The resulting boundaries of the new state are fully dealt with in the article in the present number, in which, as footnote 1, the original sources are referred to.

On November 27, 1919, at Neuilly, was signed the treaty with Bulgaria. The full treaty text is not yet available but from the summaries published in the press it would appear that the territory of Bulgaria is, in the main, left intact. On the western frontier several "rectifications" are made in favor of the Serb-Croat-Slovene State, mainly in the cession of the upper Strumitsa Valley, which had formed too close an avenue of approach to the vital Morava-Vardar artery, and in the Tsaribrod and Bosiligrad districts west of Sofia. In the south Bulgaria loses the frontage on the Aegean she gained at the end of the Balkan wars, an economic outlet to that sea being guaranteed to her, however.

The latest treaty to be taken up is that with Hungary. The conditions of peace were handed to the Hungarian delegation at Paris on January 15, 1920. The press despatches announcing this fact contain practically no reference to the territorial provisions of the treaty. According to a seemingly authentic small-scale map in the January 17, 1920, issue of *Amerikai Magyar Népszava*, a Hungarian newspaper published in New York, the boundaries of the new state seem broadly to coincide with the ethnographic limits of the compact mass of Magyars, with a tendency to lie within these limits.

With the boundaries of Hungary determined, the following countries undergoing territorial changes as a result of the war have their limits defined, completely or in part: Belgium (through the addition of Moresnet and the *Kreise* of Eupen and Malmédy), France (through the addition of Alsace-Lorraine), Italy (boundary towards Yugo-Slavia still undetermined), Yugo-Slavia (undetermined towards Italy, Rumania, and Albania), Greece (undetermined towards Turkey and Albania), Bulgaria, Rumania (undetermined towards Yugo-Slavia, Russia, and Poland), Hungary, Austria, Czecho-slovakia (undetermined towards Poland and Rumania), Poland (undetermined towards Rumania and Russia), Germany, Denmark (dependent on results of plebiscite), Finland (extent same as former Grand Duchy, with the province of Karelia and the district of Pechenga on the Arctic coast still in dispute). Among prospective countries in Europe no part of whose boundaries are definite as yet are Albania and the three Baltic states Lithuania, Latvia, and Esthonia. In Asia the countries which may be formed within the former territory of the Turkish Empire are also still without definite boundaries. These countries may possibly consist of Armenia, Syria, Palestine, Mesopotamia, and the Hedjaz. A map of Europe on the scale of 1:20,000,000 has been published by the American Geographical Society which shows the boundaries of the new states. While many of these boundaries, as stated above, are not yet defined, the map shows them in the main as recommended by the territorial experts to the Supreme Council of the peace conference, and they therefore have a certain probability. A copy of the map will be sent free on request to any Fellow of the Society, to others at 25 cents a copy.

A Frontier Custom in the Pyrenees. It is customary to quote the Pyrenees as the approximately ideal natural boundary, and it does in fact constitute the most stable political boundary of continental Europe. The antiquity of the boundary function of the Pyrenees is seen in an interesting frontier episode that has taken place at the Pass of Hernaz from times so remote that its origin is lost (Germán Baraibar y Usandizaga: En el Pirineo navarro: El tributo de las tres vacas, *Rev. de Geogr. Colon. y Mercantil*, May 1919, Real Soc. Geogr. de Madrid; see also Elisée Reclus: L'homme et la terre, Vol. 1, Paris, 1905, p. 184, and Ardouin-Dumazet: Voyage en France, Vol. 41, pp. 157-158).

Annually on July 13 the population of the French valley of Barétous (Basses-Pyrénées) pay a tribute of three cows to their neighbors of the Spanish valley of Roncal (Navarre). Functionaries, attended by villagers and pastors, meet at the boundary

stone of San Martín. After exchange of salutations the mayor from Roncal challenges his French vis-à-vis: "Come you disposed to pay the perpetual tribute of the three cows, as in the past?" The mayor of the French valley replies in the affirmative, the challenge being repeated and answered three times. The French mayor approaches the boundary stone, laying a hand upon it; a Spaniard places his on top and so on successively. The Spanish mayor completing the pile pronounces three times the phrase "Pax avant!" to which the French make the like response. With this the three cows are brought forward and, after approval by the Spanish veterinary, are accepted. Following, four guards, two French, two Spanish, are appointed to inspect the common pastures, and French and Spanish representatives proceed to hold a tribunal for the adjudication of claims and grievances. The ceremony concludes with a feast to which both parties contribute and which, with the performance of local songs and dances, testifies a happy spirit of fraternity.

Old customs linger among a conservative pastoral people, and there does not appear to be any immediate prospect of this particular custom falling in abeyance. It is said that Napoleon III tried to suppress the ceremony as being humiliating to France, but he met with vehement protests on the part of the Barétouese. Even during the recent war, in spite of the restrictions regulating the movement of cattle in the frontier zone of the Pyrenees, the ceremony continued to be held.

PHYSICAL GEOGRAPHY

Are There Persistent Irregularities in the Annual March of Temperature? There is a very widespread popular belief in the recurrence, at about the same time from year to year, of longer or shorter periods of unseasonable heat or cold. Among these "spells" perhaps the ones most commonly referred to are the "January thaw"; a cold period in May, known variously as *saints de glace, Eisheiligen*, or *gestrenge Herren;* and the Indian Summer. Professor Charles F. Marvin, Chief of the Weather Bureau has recently investigated this question (*Monthly Weather Rev.*, Vol. 47, 1919, pp. 544-555) by making a careful study of the temperature records for several long-period stations in the northeastern United States, supplemented by 45-year records from Weather Bureau stations scattered over the country. The conclusion reached is that the annual record of daily mean temperatures is a smooth curve, without secondary maxima and minima, or of perceptible points of inflection. Such marked irregularities as are described by the terms "January thaw" or "May freeze" neither persist nor do they have a real existence. In cases where these or similar irregularities persist in the means, they are nothing but the effect of a single occurrence or of a few accidentally recurrent unusual or extreme events near or at the time in question.

Those who are interested in this subject will find a useful annotated bibliography, by Professor C. F. Talman, in the same number of the *Monthly Weather Review*.

R. DeC. Ward

GEOGRAPHICAL NEWS

Obituary

Walter G. Davis, director of the Argentine Meteorological Service, died on April 30 at his old homestead in Danville, Vt. As a young man Mr. Davis went to Argentina as assistant to Dr. B. A. Gould, who established the Argentine Meteorological Service in 1872. In 1885 Mr. Davis succeeded Dr. Gould as director, continuing in that position until his retirement in 1915. Under Mr. Davis' able leadership the organization became one of the foremost government meteorological services. In 1904 the weather station at Laurie Island in the South Orkneys (60° 43′ S.) which had been established by the Scottish Antarctic Expedition, was acquired, whereby the range of observation of the Argentine service was made to embrace the whole gamut of climatic conditions from sub-tropical to sub-antarctic.

Personal

Mr. Herbert L. Bridgman gave a lecture on "Bulgaria Today and Tomorrow" on November 17 and December 2 in the system of public lectures given under the auspices of the Board of Education of the City of New York.

Professor Henry E. Crampton of the American Museum of Natural History spoke on "Tahiti and the South Seas" before the New York Academy of Sciences on December 15.

DR. DOUGLAS W. JOHNSON, professor of physiography at Columbia University, who, as major in the army, served as chief of the Division of Boundary Geography and member of several territorial commissions at the peace conference, addressed the Geographical Society of Philadelphia on November 5 on "Geographical Studies on the Western, Italian, and Balkan Fronts" and the New York Academy of Sciences on December 15 on "A Geographer at the Front and at the Peace Conference." Professor Johnson has recently published an important volume on "Shore Processes and Shore Line Development," soon to be reviewed in these pages.

PROFESSOR A. K. LOBECK of the University of Wisconsin gave a lecture on important geographical phases of the war in the "Overseas Lectures," a series of public addresses given during the academic year 1919-20 by members of the university's faculty who were actively engaged in war work. Professor Lobeck was associated with the work of the American Mission at the peace conference.

DR. S. C. SCHMUCKER of the West Chester (Pa.) Normal School gave a lecture on "The Races of Men" on November 18 before the Brooklyn Institute of Arts and Sciences, in a series of six lectures entitled "Man, Past, Present, and Future."

MR. LOUIS R. SULLIVAN, assistant curator in the department of anthropology at the American Museum of Natural History, read a paper before the American Ethnological Society on November 24 on "Notes on the Negrito Problem."

MR. E. H. WILSON, assistant director of the Arnold Arboretum, read a paper on "Korea and Its Vegetation" before the Horticultural Society of New York on December 17.

GEOGRAPHICAL PUBLICATIONS

(Reviews and Titles of Books, Papers, and Maps)

For key to classification see "Explanatory Note" in Vol. II, pp. 77-81

NORTH AMERICA

UNITED STATES

General

MACGILL, C. E., AND A STAFF OF COLLABORATORS. **History of transportation in the United States before 1860.** Prepared under the direction of B. H. Meyer. xi and 678 pp.; maps, bibliogr., index. *Carnegie Inst. Publ. No. 215 C.* Washington, D. C., 1917. $6.00.

This bulky volume is the third contribution to American economic history by the Department of Economics and Sociology of the Carnegie Institution of Washington. As a basis for this comprehensive work special studies, of which a list is included in the preface, were made by a number of collaborators for a period of about ten years. Some of these studies already have been published, while others are still in manuscript in the hands of the Carnegie Institution. The task of Miss MacGill was to weave all of the various basic studies into a whole, filling in the gaps here and there, as found necessary, by her individual research. The present volume in conjunction with the various basic studies, when all are published, will constitute a fairly complete history of transportation in the United States from the earliest times down to the period of the Civil War.

The book contains seventeen chapters, the last seven of which, filling approximately one half of the volume, are concerned primarily with a discussion of the development of railways. Both the evolutionary and the sectional viewpoints of the growth of the country's transportation systems are kept in mind, so that the earlier chapters treat of early trails, roads, and natural waterways; tolls and transportation charges on early roads and canals; traffic by rivers; trails and roads in the trans-Appalachian region; early land routes in Ohio; waterways in New England; canals and water routes in New York; canals and waterways in Pennsylvania; roads, canals, and waterways in the South; transportation in the Middle West before the railroad era; and plank roads.

The reader of this volume will probably be somewhat disappointed that, at times, a great many details have been included which are of little more than local interest and that the broader general aspects of transportation development have not been more prominently set forth. As remarked by Dr. Meyer, however, the volume "must be viewed as a contribution rather than as a completed study. It seemed much better to utilize as far as possible all of the material which the various collaborators had brought together than to restrict the volume to only such material as would be required in producing a thoroughly systematic, unified, and closely knit book." From this point of view Miss MacGill has, on the whole, done an excellent piece of work. The material has been well marshaled, the underlying influences have been placed in the foreground, and prominence has been given to many of the relatively important questions in transportation development.

To those interested in the influence of geographical factors in history it is gratifying to note that certain geographical factors have not been overlooked as having played a prominent part in the development of the various means of transportation. For example, the first paragraph of the first chapter emphasizes the importance of the physical environment by discussing the Appalachian barrier as follows: "The physiography of that part of the United States which was in process of settlement in the country's early decades was an important factor in determining the geographical distribution of the increasing population. The first settlements had been made in the narrow strip of land lying between the Appalachian Mountains and the Atlantic Ocean. In the earlier periods these settlements were necessarily isolated from each other, and they were compelled by the mountain wall to expand within the coastal region rather than into the interior. A few trails led into the back country, but almost throughout its entire length the mountain barrier was so difficult to overcome that when small settlements were finally established across the Alleghenies any sort of communication with the

older colonies was infrequent and irregular. The development of these trans-Appalachian settlements was conditioned upon the development of ways and means of transportation. They needed the markets and the products of the East for the development of any economy except one of an essentially primitive and simple character. From 1750 to 1800, however, their isolation was scarcely broken, and their interests seem to have been local, or at least to have been little regarded by the more populous communities of the East. The early history of transportation, in its national aspects, is largely occupied with an account of efforts, originating sometimes in the East and sometimes in the West, to break through this mountain barrier and establish regular routes of travel connecting the Ohio and Mississippi Valleys with the Atlantic seaboard'' (p. 3).

In various other connections the importance of geographical factors is emphasized, as, for example, in discussing the development of canals and water routes in New York state and in Pennsylvania, and in considering the development of roads, canals, waterways, and railways in the South. With reference to the latter it is stated: ''As it came to be developed in the South at large, the transportation system was a composite of land and water ways, supplementing one another with more or less efficiency for a common end. There was, first, the ocean highway, with reference to which it may be noted that the resort to ocean steamships after about 1820 freed the traffic from dependence upon currents of wind and water and enabled mariners to use the shortest transatlantic route, thereby building up the Northern ports at the expense of those of the South. Closely akin was the navigation of rivers and sounds, and so-called rivers, such as the Potomac and the James in their lower courses, and the bayous of Louisiana, in which there was an appreciable current. . . . Even in the Piedmont country the rivers could be used in flood season to transport small boats with light cargoes, but could hardly be used at all for the upward journey. The introduction of steamboats provided means for upward navigation as far as the fall-line, but they affected the river problem within the Piedmont very little'' (p. 415).

The book contains a full classified bibliography of forty pages. There are maps showing the navigable rivers of the United States, the canals, and the railroads in operation in 1840, 1850, and 1860. AVARD L. BISHOP

GILBERT, C. G., AND J. E. POGUE. **The energy resources of the United States: A field for reconstruction.** x and 165 pp.; maps, diagrs., ills. *U. S. Natl. Museum Bull. 102*, Vol. 1. Smithsonian Inst., Washington, D. C., 1919.

MEINZER, O. E. **Bibliography and index of the publications of the United States Geological Survey relating to ground water.** 169 pp.; map. *U. S. Geol. Survey Water-Supply Paper 427*. Washington, D. C., 1918.

PORTER, J. G. **All-American time: A scientific time system for the United States.** 7 pp.; map. *Univ. of Cincinnati* [*Publs.*], Ser. 4, Vol. 1, 1918.

SHAW, E. W. **Ages of peneplains of the Appalachian province.** *Bull. Geol. Soc. of Amer.*, Vol. 29, 1918, No. 3, pp. 575-586.

SMITH, GEORGE O. **A century of Government geological surveys.** *Amer. Journ. of Sci.*, No. 271, Ser. 4, Vol. 46, 1918, July, pp. 171-192. New Haven.

SMITH, MIDDLETON, O. E. BAKER, AND R. G. HAINSWORTH. **A graphic summary of American agriculture.** Maps, diagrs. *Yearbook of Dept. of Agric. for 1915*, pp. 329-403. Washington, D. C., 1916. [See the reference in the May, 1919, *Review*, p. 345.]

—— **U. S. Geographic Board, Decisions of the, July, 1916-July, 1918.** 34 pp. Washington, D. C., 1919.

—— **U. S. Geographic Board, Decisions of the.** 7 pp. Washington, D. C., 1919. [Including decisions of the Philippine Committee on Geographical Names, approved by the U. S. Geographic Board, Dec. 4, 1918.]

WARD, R. DEC. **The larger relations of climate and crops in the United States.** Map, bibliogr. *Quart. Journ. Royal Meteorol. Soc.*, No. 189, Vol. 45, 1919, pp. 1-19 (discussion, p. 19). London. [See the note in the May, 1919, *Review*, p. 345.]

North Atlantic States

CHAMBERLAIN, ALLEN. **Vacation tramps in New England highlands.** 164 pp.; maps, ills. Houghton, Mifflin & Co., Boston and New York, 1919. $1.25. 7 x 4½.

Here is an altogether charming account of walks over that most primitive of highways, as well as most poetic, the trail. Mr. Chamberlain takes his readers through the White Mountains of New Hampshire, the Green Mountains of Vermont,

and the regions about Mt. Katahdin in Maine. The volume is in no sense a guidebook, although it serves that purpose admirably. Its appeal is quite as much to the stay-at-homes in quest of delightful and stimulating accounts of the high spots in our country. Mr. Chamberlain has a good deal of Thoreau's taste for tramping as well as a good deal of his art in communicating to others the joys of the wilderness trails.

After preliminary chapters dealing with the scenic worth of the New England highland and the pedestrian's kit, the author describes with rare fascination a summer sauntering afoot through the White Mountains, a journey from Johnson over the Sterling Mountains to Mt. Mansfield and the Couching Lion, a tramp along the Green Mountain Club's Long Trail from the Lincoln-Warren Pass over the Lincoln, Stark, and Burnt Mountain ranges, an autumn tour through the mountains of southern Vermont, midwinter trips to the roof of New England and the Mt. Washington region, and a summer camping tour to the little-known Katahdin country in Maine. Students of American geography, as well as all lovers of out-of-door life, will find much to interest them in Mr. Chamberlain's significant little volume. WILL S. MONROE

BIDWELL, P. W. **Rural economy in New England at the beginning of the nineteenth century.** Map, bibliogr. *Trans. Connecticut Acad. of Arts and Sci.*, Vol. 20, 1916, pp. 241-399. New Haven.

HARPER, R. M. **A sketch of the forest geography of New Jersey.** Map, ills. *Bull. Geogr. Soc. of Philadelphia*, Vol. 16, 1918, No. 4, pp. 107-125. [Valuable account, based on personal knowledge and on thorough familiarity with the available phytogeographical literature. The state is divided into nine natural regions, shown on a map, viz: Kittatinny Mountain, Kittatinny Valley, the Highlands, the Triassic Region, the Greensand Marl Belt, the Pine Barrens, the Cohansey Region, the Cape May Region, and the Coast Strip. The forest geography of each region is briefly characterized, a "quantitative analysis," in the author's customary manner, being given of the predominant trees in each region, also the percentage of forested area, based mainly on Vermeule in the 1899 forest report of the State Geological Survey. The relation of forest growth to soils receives the attention it deserves, in which connection it is of interest to note that the author believes that "the existing differences between the vegetation of the Pine Barrens and that of the surrounding country are so obviously correlated with present soil conditions that it seems quite unnecessary to invoke" a Pensauken submergence "to explain them."]

MUNRO, W. H. **Tales of an old sea port.** 292 pp.; ills., index. Princeton University Press, Princeton, 1917. $1.50. 8½ x 6. [Chiefly personal narratives of voyages made by sailors from Bristol, R. I. They include the voyage of the *Juno* by Captain John De Wolf, "A Voyage to the North Pacific and a Journey through Siberia more than half a century ago," printed in Cambridge, 1861.]

—— **New Jersey, State of: Census of 1915.** 98 pp. Dept. of State, Trenton, N. J., 1916.

—— **New York, State of: State Commissioner of Highways, Report of the, [for 1915.]** 939 pp.; maps, ills., index. J. B. Lyon Co., Albany, 1916. [Chiefly statistical in character, with some good photographic illustrations. Of geographical interest is the section on maps, page 19, in which we learn that the Department of Highways has been preparing a map of the state which will show completed state and county highways and also the true condition of those under contract. The map is being prepared in such a way that it can be added to as contracts are finished. Pending the completion of this fundamental map, two simpler maps on the scale of 1:570,000 have been issued, copies of which accompany the present report. The first shows the legal status of the state and county highways, the second, the physical condition of state, county, and town roads and the location of points of historical interest along them.]

—— **New York, The greater port of.** Ills. *Dun's Rev.: Internatl. Edit.*, Vol. 29, 1917, No. 2, pp. 36-38 and 49.

—— **New York Central Railroad, The, 1831-1915.** 31 pp.; ills. New York Central Railroad, [New York], 1916. 8 x 5½.

—— **New York's multitudes, Moving.** Ills. *Dun's Rev.: Internatl. Edit.*, Vol. 27, 1916, No. 2, pp. 35-38. [Gives Police Department figures for street traffic of New York City. The four busiest points, with the traffic in a ten-hour day, are: western end of Brooklyn Bridge, 300,000 pedestrians and 7,000 vehicles; Broadway and Fulton Street, 233,000 pedestrians and 10,300 vehicles; Fifth Avenue and 34th Street, 140,000 pedestrians and 14,300 vehicles; Fifth Avenue and 42nd Street, 114,000 pedestrians and 18,800 vehicles. See also section and diagrams on traffic in E. P. Goodrich's article in the September, 1916, *Review* (Vol. 2, pp. 201-204).]

—— **Pennsylvania, Descriptive review showing development of the state of; containing in addition newly engraved maps of every state in the United States, and detail maps of every county, state, and kingdom, together with a complete locating index to all cities, towns, villages, and post offices in the United States, giving populations to every incorporated city and village therein.** 374 pp.; maps (107 pp.), ills. George F. Cram Co., Chicago and New York, 1917. 15 x 12. [A gazetteer of counties, cities, boroughs, and villages.]

PERKINS, G. H. **The physiography of Vermont.** *Science*, No. 1256, Vol. 49, (N. S.), 1919, January 24, pp. 77-81.

SAUER, C. O. **The role of Niagara Falls in history.** Map, ills. *Hist. Outlook*, Vol. 10, 1919, No. 2, pp. 57-65. Philadelphia. [Abstracted in the *Journ. of Geogr.*, April, 1919, pp. 158-159.]

—— **United States coast pilot: Atlantic coast, Section B, Cape Cod to Sandy Hook.** 326 pp.; maps, index. *U. S. Coast and Geodetic Survey Serial No. 91.* Washington, D. C., 1918.

—— **White Mountains and adjacent regions, Guide to paths in the (revised 1917).** xi and 424 pp.; maps, index. Appalachian Mountain Club, Boston, Mass. 6 x 3½. [The standard mountaineering guide of this region. There are 8 sectional contour maps on the scale of 1:160,000, reproduced in heliotype, bound in the book; 4 text maps, including two showing Mt. Monadnock and Mt. Katahdin; and 2 folded maps in a pocket, one of the Mt. Washington Range, 1:62,500, contour interval 100 feet (heliotype), and the other of the northern peaks of the range, 1:40,000, contour interval 100 feet (lithograph; contours in brown, drainage in blue, rest in black).]

—— ***Long Island Sound, North Shore of, Milford to Stratford, including Housatonic River, Connecticut.*** 1:20,000. U. S. Coast and Geodetic Survey Chart No. 219. Washington, D. C., Feb., 1919.

—— ***Bangor and Brewer, Maine, A survey of.*** Based on records and plans in the City Engineer's Office. [1 inch to 800 feet, or 1:9,600.] The National Survey Co., Portland, Me., 1914.

—— [***New England states and New York, Maps of.***] (1) ***The official map of Maine.*** [1 inch to 7 miles, or 1:443,520.] (2) ***The official map of Vermont and New Hampshire.*** [1 inch to 4½ miles, or 1:285,120.] (3) ***The official map of Southern New England, comprising Massachusetts, Connecticut, and Rhode Island.*** [1 inch to 4½ miles, or 1:285,120.] (4) ***The official map of New York.*** [1 inch to 7 miles, or 1:443,520.] ***Compiled from United States government surveys, official state surveys, and original sources.*** The National Survey Co., Chester, Vt., 1915, 1918. [Carefully compiled and neatly drawn maps. No relief is shown, but the locational elements are given in great detail. Four classes of roads are distinguished, trolley lines are shown, and there is great refinement in the notation of the status of towns or villages, no less than thirteen symbols being used to indicate the existence of post, telegraph, and express offices, country stores, and banks.]

—— ***New York, Canal map of the state of.*** [1 in. to 12½ miles, or 1:762,000.] Inset: Profile of Barge Canal. 1 in. to 15 miles. State Engineer and Surveyor, Barge Canal Office, Albany, N. Y., 1918.

South-Central States

SNIDER, L. C. (AND OTHERS). **Geography of Oklahoma.** *Oklahoma Geol. Survey Bull. No. 27.* 325 pp.; maps, ills. Norman, 1917.

This is a very creditable piece of work, considering the short time Oklahoma has been inhabited by civilized man, and it gives a better account of the local geography than we have at present of many much older states. The fact that most of the inhabitants of Oklahoma were born in other states, a few to several hundred miles away, and have thus had experience with different environments, has probably had a stimulating influence on geographical research in that state. The principal author was assistant director of the Oklahoma Geological Survey in 1913-14, but several of the chapters were contributed or revised by others after he left the state. This makes the treatment a little uneven.

Of the three large maps (printed in black and white on paper too thin to stand much handling) the first is an ordinary political map, the second a geological map, and the third, called a "physiographic map," is a map of the geographical regions. The half-tones are well selected to illustrate the scenery and resources; but, being printed in the text (though erroneously called plates) on rather cheap paper, they are not very brilliant.

About 11 pages are devoted to boundaries, topography, and drainage, 9 to climate,

and 15 to geology. Then follows the portion of chief interest to geographers, Chapter 3, on "physiographic provinces." These are eleven in number and correspond in a general way with geological formations. About three pages on the average are devoted to each region, about half the space being taken up with stratigraphy and the rest with topography, drainage, soil, vegetation, population, etc.

Then follow several chapters in which the geographical point of view is not very prominent, including 38 pages on mineral resources, 12 on agriculture, 9 on history, 30 on educational institutions, 30 on animals (nearly half of which is a bare list of species without localities), 32 on plants (with an annotated list of trees and shrubs, condensed from Circular 4 of the same organization, published about five years earlier but containing many cultivated species and some others whose occurrence in Oklahoma seems very improbable), and finally a brief sketch, about a page in length, of each of the 77 counties.

The eleven regions, beginning with the northeasternmost, are the Ozark, Ouachita, Arbuckle, and Wichita Mountains, the Red River Valley, or Cretaceous region (a part of the coastal plain, being the northward extension of the black prairies of Texas), the Lower Arkansas Valley, the Sandstone Hills (continuous with the flint hills of Kansas), the Prairie Plains, the Red Beds Plains, the Gypsum Hills, and the High Plains. Two of these, the Arbuckle and Wichita Mountains, are small unique regions confined to Oklahoma, and the former is noteworthy for containing a number of travertine falls, which have been described in a separate bulletin (*Bull. 29*). The regions all seem to differ as much in soil, vegetation, etc., as they do in topography.

The principal mineral resources seem to be oil and gas, coal, sandstone, clay, and gypsum, and the leading crops corn, cotton, wheat, alfalfa, broom corn, and kafir corn. The commonest tree in the state is said to be the blackjack oak (*Quercus marilandica*); and hardwoods greatly predominate over conifers, on account of the prevailingly fertile soils. The greater part of the state is treeless, however, the forests being chiefly in the eastern third.

The bulletin has no chapter specially devoted to population, and no index; but the table of contents is conveniently arranged, and the county descriptions are in alphabetical order. ROLAND M. HARPER

—— ***Gulf Coast, Galveston to Rio Grande.*** [1:460,000.] U. S. Coast and Geodetic Survey Chart No. 1117. Washington, D. C., March, 1919.

—— ***Lakes Pontchartrain and Maurepas, Louisiana.*** 1:80,000. U. S. Coast and Geodetic Survey Chart No. 1269. Washington, D. C., Feb., 1919.

—— [***Topographic map of the United States.***] ***Camp Taylor and Vicinity, Ky.*** 1:62,500. U. S. Geol. Survey, Washington, D. C., 1918. [With account of "The Country in and Around Camp Taylor," by Charles Butts, on the back of the sheet.]

WEST INDIES

BOOY, THEODOOR DE, AND J. T. FARIS. **The Virgin Islands: Our new possessions and the British islands.** 292 pp.; maps, ills., bibliogr., index. J. B. Lippincott Co., Philadelphia and London, 1918. $3.00. 8½ x 5½.

The picturesque story of "The Virgin Islands of the United States" was briefly told by the late Mr. de Booy in the *Review* (Vol. 4, 1917, pp. 359-373). In this volume, of which Mr. de Booy was joint author, it is told in detail, and there is added a chapter on the British islands that geographically are members of the group. The chief material used in preparation of the book was gathered by Mr. de Booy during his archeological explorations for the Museum of the American Indian, Heye Foundation. To his archeological labors, of much scientific interest, reference here is made merely to complete the historical picture, for the book has been designed particularly for the tourist and the business man. With their needs in view have been added a chapter of "Hints for the Tourist" and another of statistical information. The bibliography also will be found useful.

ZABRISKIE, L. K. **The Virgin Islands of the United States of America: Historical and descriptive, commercial and industrial facts, figures, and resources.** xvii and 339 pp.; maps, index. G. P. Putnam's Sons, New York and London, 1918. $4.00. 8½ x 6.

Discovered by the great Genoese admiral in the employ of Spain, settled by Dutch, English, and French, owned by Denmark for 250 years, peopled at present almost entirely by Africans who speak the English language, and now under the American flag, though at one time courted and probably almost won by Germany with her scheme of commercial expansion; once the entrepôt of ships from every nation, later almost for-

gotten in an unfrequented nook of the Caribbean; today once more destined to play an important rôle as guardian to the world's new gateway—this is the story of the Virgin Islands. With an area of only 139 square miles, few natural resources, and a population of but 27,000 people, these islands cost the United States more than the Louisiana Purchase and Alaska combined, and many Americans have wondered if the bargain was worth while.

The present volume does not attempt to answer that question fully. More space is given to details of the commercial situation, port regulations, currency, and means of communication than to the strategic importance of the islands or the suitability of their harbors as a naval base. The author, former vice consul of the United States at St. Thomas, writes almost entirely from a commercial viewpoint. The book will serve as a useful guide to any person who may contemplate trade or investment in these recently acquired possessions. It tells, too, of many incidents connected with the purchase and transfer of the islands from Denmark to the United States, giving, besides, a sympathetic description of the inhabitants and their ways of life. This should render it of a certain permanent historical value. The excellent illustrations help to compensate for a rather hasty composition and faulty editing.

ASPINALL, A. E. **The pocket guide to the West Indies: British Guiana, British Honduras, the Bermudas, the Spanish Main, and the Panama Canal.** New edit. 488 pp.; maps, ills., index. Rand, McNally & Co., Chicago and New York, 1914. $1.50. 7 x 4.

BOOY, THEODOOR DE. **On the possibility of determining the first landfall of Columbus by archaeological research.** *Hispanic Amer. Hist. Rev.*, Vol. 2, 1919, No. 1, pp. 55-61. Baltimore.

CABON, ADOLPHE. **Contribution à l'étude de la géographie d'Haïti: Notes bibliographiques sur la géographie d'Haïti.** (1) **Bibliographie de la géographie de l'île au temps de la colonie espagnole, 1492-1630,** (2) **Bibliographie de la géographie de l'île d'Haïti au temps de la colonie française, 1640-1789,** (3) **Note sur la cartographie d'Haïti.** *Bull. Semestriel de l'Observ. Météorol. du Séminaire-Collège St-Martial*, 1916, July-Sept., pp. 149-174. Port-au-Prince, Haiti.

CABON, ADOLPHE. **Notes historiques sur la détermination de la position géographique d'Haïti.** *Bull. Semestriel de l'Observ. Météorol. du Séminaire-Collège St-Martial*, 1916, Jan.-June, pp. 51-67. Port-au-Prince, Haiti.

HALL, MAXWELL. **West Indies hurricanes as observed in Jamaica.** Map, diagrs., ill. *Monthly Weather Rev.*, Vol. 45, 1917, No. 12, pp. 578-588.

HARRIS, GARRARD, AND VARIOUS AMERICAN CONSULAR OFFICERS. **The West Indies as an export field.** 378 pp.; map, ills., bibliogr. *U. S. Dept. of Commerce Special Agents Ser. No. 141.* Washington, D. C., 1917. [This report contains a good general description of each island, including even such minor groups as the Cayman, the Dutch West Indies, and the British Virgin Islands. Situation, climate, soil, resources, population, means of communication, etc., are considered. A list of recent books on the West Indies and of Department of Commerce monographs covering the same field forms the appendix.]

JONES, WILLIAM F. **A geological reconnaissance in Haiti: A contribution to Antillean geology.** Diagrs., ills. *Journ. of Geol.*, Vol. 26, 1918, No. 8, pp. 728-752. [Contains a section on topography and, on the insert plate, a small but clear map showing the topographic divisions of the island of Haiti.]

ORTEGA, PABLO. **Petroleum in Cuba.** Ills. *The Cuba Rev.*, Vol. 16, 1918, No. 11, pp. 17-23. New York.

EUROPE

SCANDINAVIA, INCLUDING FINLAND

MADSEN, V. H. O., edit. **Den Danske Gradmaaling. No. 11: Konstantbestemmelser ved relative Pendulmaalinger.** 115 pp.; diagrs. **No. 12:** V. H. O. MADSEN and N. P. JOHANSEN. **Astronomisk Bestemmelse af Laengdedifferensen mellem Kjøbenhavns Observatorium og Buddinge samt af Azimuthet i Buddinge af Retningen mod Nikolaj Taarn.** 115 pp. **No. 13:** V. H. O. MADSEN AND N. M. PETERSEN. **De danske Kysters Middelvandstande og disses Reduktion til "stille" Polhøjdevarationens Indflydelse.** 118 pp.; diagr. **No. 14:** V. H. O. MADSEN AND AAGE PETERSEN. **Registeringsapparat til Tyngdemaalingspenduler.** 14 pp. **No. 15:** V. H. O. MADSEN AND M. J. SAND. **Nye Basismaalinger i Danmark.** 84 pp.; diagrs. Copenhagen, 1913-1916.

Under General Madsen as Director the Danish Coast and Geodetic Survey has now

brought up to date the published record of its accomplishments during the hundred years of its existence. The volumes are excellently printed and contain maps and diagrams to illustrate the different phases of the work.

In Volume 11 is found a discussion of the measurements of the intensity of gravity. The Danish Fechner apparatus had been sent to Potsdam to determine the pendulum constants necessary for a reduction of observations to a vacuum at 0° C. in 1904, and, some doubt of the validity of these reductions having arisen, a new determination with improved electrical thermostat was made in 1913. A satisfactory formula finally resulted, and graphical methods were introduced to facilitate approximate determinations.

The first part of Volume 12 contains the determination of the difference in longitude between the observatory of Copenhagen and Buddingen, with a detailed description of stations and methods. The second part discusses a determination of an azimuth at Buddingen and a critical analysis of the mean error of the results.

Volume 13 contains a rehandling of the results of sea-level determinations. The periodic annual variation was determined and the relation of barometric heights under the La Cour hypothesis.

Volume 14 contains a description of a device for registering photographically on the cylinder of a chronograph the curves obtained from the swinging of pendulums.

In Volume 15 are found two new base measurements. The triangulation of Denmark depends upon the Copenhagen base measured by Schumacher in 1838. The new determination in 1911 with a Jäderin apparatus gave a length of 51 millimeters, or 1/53,000 greater. In order to be sure that the discrepancy was not due to systematic error, the Potsdam auxiliary base was measured ten times and the Prussian value checked to 1/3,000,000. In 1913 another Danish base was measured and the result checked to 1/1,000,000, with its length computed from the work of 1838. This indicates that the old work may be accepted and that the length of the Copenhagen base has changed since 1838, the reason for which will have to be determined by subsequent research.

JAMES GORDON STEESE

FØYN, N. J. **Das Klima von Bergen. Part II: Lufttemperatur.** *Bergens Museums Aarbok 1915-16: Naturvidenskabelig Raekke No. 4*, pp. 1-88.

HOWORTH, H. H. **The recent geological history of the Baltic and Scandinavia and its importance in the Post-Tertiary history of western Europe.** *Geol. Mag.*, Decade 6, Vol. 5, 1918, No. 8, pp. 354-367; No. 9, pp. 397-409; No. 10, pp. 451-461. London.

OSTENFELD, C. H. **Randersdalens Plantevaekst.** Pp. 155-270; maps, ills. Extract from "Randers Fjords Naturhistorie," Ch. 4. Bianco Lunos, Copenhagen, 1918. [Part of a study of the plant ecology of the Randers Firth on the east coast of Denmark.]

THORODDSEN, THORVALDUR. **Árferdi á Íslandi í thúsund ár.** Part I: 192 pp. Part II: pp. 193-432. Íslenska Fraedafjelagi í Kaupmannahöfn, Copenhagen, 1916, 1917. 9 x 6. ["The Seasons in Iceland for a Thousand Years." Mainly a compilation from contemporary observations on the weather for the period 865-1900, with critical comment.]

WALLÉN, AXEL. **Sambandet mellan klimat och skörd i Sverige.** Maps, diagrs., bibliogr. *Ymer*, 1918, No. 1, pp. 1-23. Stockholm. [Relation between climate and crops in Sweden.]

WALLÉN, AXEL. **Sur la corrélation entre les récoltes et les variations de la température et de l'eau tombée en Suède.** 87 pp.; maps, diagrs. *Kungl. Svenska Vetenskapsakademiens Handlingar*, Vol. 57, 1917, No. 8. Stockholm.

SPAIN, PORTUGAL

BARANDICA Y AMPUERO, MANUEL DE. **Determinación relativa de la intensidad de la fuerza de gravedad en Roldán, Cartagena y Torrejón.** 66 pp.; diagrs. *Memorias Inst. Geogr. y Estadíst.*, Vol. 14, No. 1. Madrid, 1914.

BLÁZQUEZ, ANTONIO. **Mapas antiguos adquiridos por la Sociedad Bilbaína y un mapa de Juan Oliva, de 1591.** Ills. *Bol. Real Soc. Geogr.*, Vol. 60, 1918, No. 2, pp. 207-230. Madrid. [Old maps of Spain.]

CARANDELL, JUAN, AND JOAQUÍN GÓMEZ DE LLARENA. **El glaciarismo cuaternario en los Montes Ibéricos.** 62 pp.; maps, diagrs., ills., bibliogr. *Trab. Museo Nacl. de Cienc. Nat., Ser. Geol. No. 22.* Madrid, 1918. [The Iberian Mountains between the Spanish Meseta and the Ebro Valley.]

GALBIS Y RODRÍGUEZ, JOSÉ. **Determinaciones relativas de la intensidad de la gravedad.** 133 pp.; diagrs., ills. *Memorias Inst. Geogr. y Estadíst.*, Vol. 14, No. 2. Madrid, 1918. [All the stations occupied are in Spain.]

GAVALA Y LABORDE, JUAN. **Descripción geográfica y geológica de la Serranía de Grazalema en la provincia de Cádiz.** Maps, diagrs., ills. *Bol. Inst. Geol. de España*, Vol. 39 (Vol. 19, 2nd Ser.), 1918, pp. 3-143. Madrid.

KINDELAN, VICENTE. **Criaderos de hierro de las provincias de Guadalajara y Teruel.** Maps, diagrs., ills., bibliogr. *Memorias Inst. Geol. de España*, Vol. 3, pp. 1-176. Madrid, 1918.

LUCCI, L. F. DE L. S. **Estudos geográficos: Alterações litorais a ria de Aveiro.** 70 pp.; map, bibliogr. Lisbon, 1918. 9 x 6½. [Portugal.]

MERINO, ABELARDO. **El regionalismo peninsular: La antropología y la etnografía.** *Bol. Real Soc. Geogr.*, Vol. 60, 1918, No. 2, pp. 137-206. Madrid. [Anthropology and ethnography of Spain.]

MICHAVILA, ANTONIO. **La barraca valenciana.** Ills. *Rev. de Geogr. Colon. y Mercantil*, Vol. 15, 1918, No. 8-10, pp. 281-330. Real Soc. Geogr., Madrid. [Those who have found delight in Blasco Ibañez's "The Cabin" will doubly appreciate this geographical interpretation of life in the Vega of Valencia.]

NAVARRO, BENJAMÍN. **El Valle de Carriedo.** Maps, ills. *Iberica*, No. 238, Vol. 10, 1918, July 27, pp. 75-79; No. 243, Sept. 14, pp. 154-157. Tortosa. [A mountain basin on the seaward slope of the Cantabrian Mountains south of Santander.]

—— **Real Sociedad Geográfica: Anuario de 1919.** 87 pp. Madrid, 1919. 4½ x 3½.

—— **Real Sociedad Geográfica, Catálogo de mapas, planos y dibujos de la biblioteca de la.** *Rev. de Geogr. Colon. y Mercantil*, Vol. 14, 1917, No. 3, pp. 114-120; No. 4, pp. 153-160; No. 5-6, pp. 198-240; No. 7-8, pp. 308-320; No. 9, pp. 359-360; No. 10-11, pp. 439-440; No. 12, pp. 462-471; Vol. 15, 1918, No. 1, pp. 35-40; No. 2, pp. 74-80; No. 4-5, pp. 197-200. Real Soc. Geogr., Madrid.

RUBIO, J. M. **Notas de hidrología subterránea en la provincia de Almería.** *Bol. Inst. Geol. de España*, Vol. 39 (Vol. 19, 2nd Ser.), 1918, pp. 387-419. Madrid.

SANS Y HUELIN, GUILLERMO. **Determinaciones relativas de la intensidad de la gravedad.** *Memorias Inst. Geogr. y Estadíst.*, Vol. 14, No. 4, 65 pp., ills.; No. 5, 59 pp., ills. Madrid, 1915, 1918. [All the stations occupied are in Spain.]

VERA, J. P. **Geografía de España y Portugal (estudiada a base de las grandes regiones naturales).** (Ser. Geografía, Vol. 3.) 194 pp.; maps, bibliogr. Seix & Barral Herms., Barcelona, 1915. 7½ x 5½. [One of a series of three school geographies, attractively produced and betokening the influence of modern methods. In the same space as the other two books (Vol. 1, Mathematical and Physical Geography; Vol. 2, Regional Geography of the World) and therefore in more detail, the present book deals with the Iberian Peninsula and is therefore of special interest.]

VIDAL, L. M. **Paleogeografía de Cataluña.** Ills. *Iberica*, No. 244, Vol. 10, 1918, September 21, pp. 171-176. Tortosa.

AFRICA

CONGO BASIN AND LOWER GUINEA

ANDRIMONT, RENÉ D'. **Le Katanga et ses richesses minérales.** Map, ills. *La Nature*, No. 2255, 1916, Dec. 16, pp. 385-391. [Abstracted in the *Review*, Vol. 4, 1917, pp. 220-221.]

—— **Belgian Congo, The, 1917: Agriculture, stockbreeding, and forestry.** Ills. *African World*, No. 817, Vol. 63, 1918, July 6, pp. i-xvi (=Special Equatorial African Supplement). London.

BRONNE, CHARLES. **Le Congo belge.** Map, ills. *Colonies et Marine*, Vol. 3, 1919, No. 1, pp. 51-65. Paris.

DIELS, L. **Vegetationstypen vom untersten Kongo.** 16 pp.; ills. (Vegetationsbilder, Ser. 12, No. 8. Herausgegeben von G. Karsten and H. Schenck.) Gustav Fischer, Jena, 1915.

DINIZ, FERREIRA. **Provincia de Angola: Negocios indigenas.** *Bol. Soc. de Geogr. de Lisboa*, Ser. 35, 1917, No. 7-9, pp. 163-206.

GALVÃO, A. **Relatorio duma viagem ao Congo em Agosto e Setembro de 1915.** Maps, diagrs. *Bol. Soc. de Geogr. de Lisboa*, Ser. 36, 1918, No. 4-6, pp. 81-155. [A description of the Congo district in the northwest corner of Portuguese West Africa (Angola). Although devoted largely to a consideration of the means of communication (existing and possible), the account contains also some data regarding the geology, hydrography, resources, and inhabitants of the region.]

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